MARCH 1968 35 CENTS

Popular Science

MONT

Mario Andretti Tests Hot New AMX Sports Car

What's New in GARDEN TRACTORS

DICK VAN DYKE Rides Zaniest Car

Lie-Flat Blueprint: Build Your Own SUPERCHAIR

EXCLUSIVE! Deep-Diving 'Lab" for My 1,500-Mile Drift Under the Atlantic by Dr. JACQUES PICCARD

When You Buy a Used Car– What NOT to Look For

How to Get Started Racing By SMOKEY YUNICK

Army's 250-m.p.h. Chopper Can Loop and Roll!

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And, as an aeronautical engineer, he also enjoys Popular Science's sound and timely reports of developments in science and technology.

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Cordially,

Charles S. Thorn

Charles S. Thorn
Executive Vice President
Advertising Sales

March, 1968

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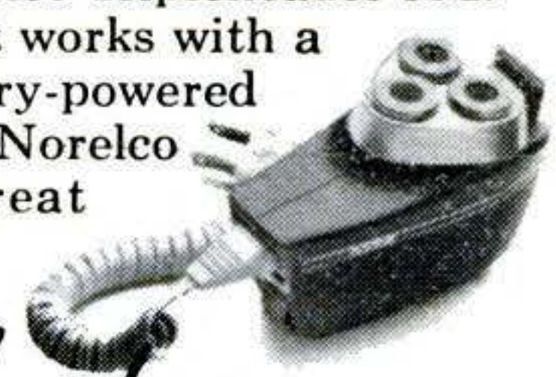

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My Deep-Diving "Lab" BY DR. JACQUES PICCARD PAGE 65
The famous oceanologist tells how his fabulous PX-15 will drift in the Gulf Stream, down in the lightless depths, on a 42-day voyage of discovery.

How to Get Started in Racing BY SMOKEY YUNICK PAGE 70
Expert knowledge, courage, skill, confidence—and luck—are all you need.

Army's 250-m.p.h. Chopper Can Loop and Roll! PAGE 80
The Cheyenne, latest in Army gunships, also has a big civilian job waiting.

What Not to Look for When Buying a Used Car PAGE 84
Kick the tires if you must—but the smart buyer should know what's **really** important.

How to Build the Superchair BY KEN ISAACS PAGE 160
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COMING NEXT MONTH

A feast of fact-filled features on some fascinating subjects. For example:

WANKEL ENGINES: Now it's the Japanese who are making news with rotary-combustion cars.

VIETNAM: PS's Bob McCall visited Vietnam and painted what he saw. Here—in vivid color—are this top artist's views of the war.

SOARING: Bob Gannon shares with you a new thrill—a half-mile up without an engine.

HEART TRANSPLANTS: Amazing new facts on a medical phenomenon, by Lawrence Galton.

ASTRONOMY: Famous TV personality Hugh Downs tells you how—and why—he builds telescopes.

NORBYE/DUNNE: Our driving duo report on the Cutlass, Montego, Charger, and Rebel SST.

DREAM STEREO SYSTEM: Electronics Editor Ron Benrey prescribes the perfect 1968 hi-fi.

50 PAGES OF HOME IMPROVEMENT: Ideas, techniques, projects, and products to make your home a happier place to live in.

PLUS: A special 16-page Bonus Section with all the news—and there's plenty!—about TIRES FOR YOUR CAR.

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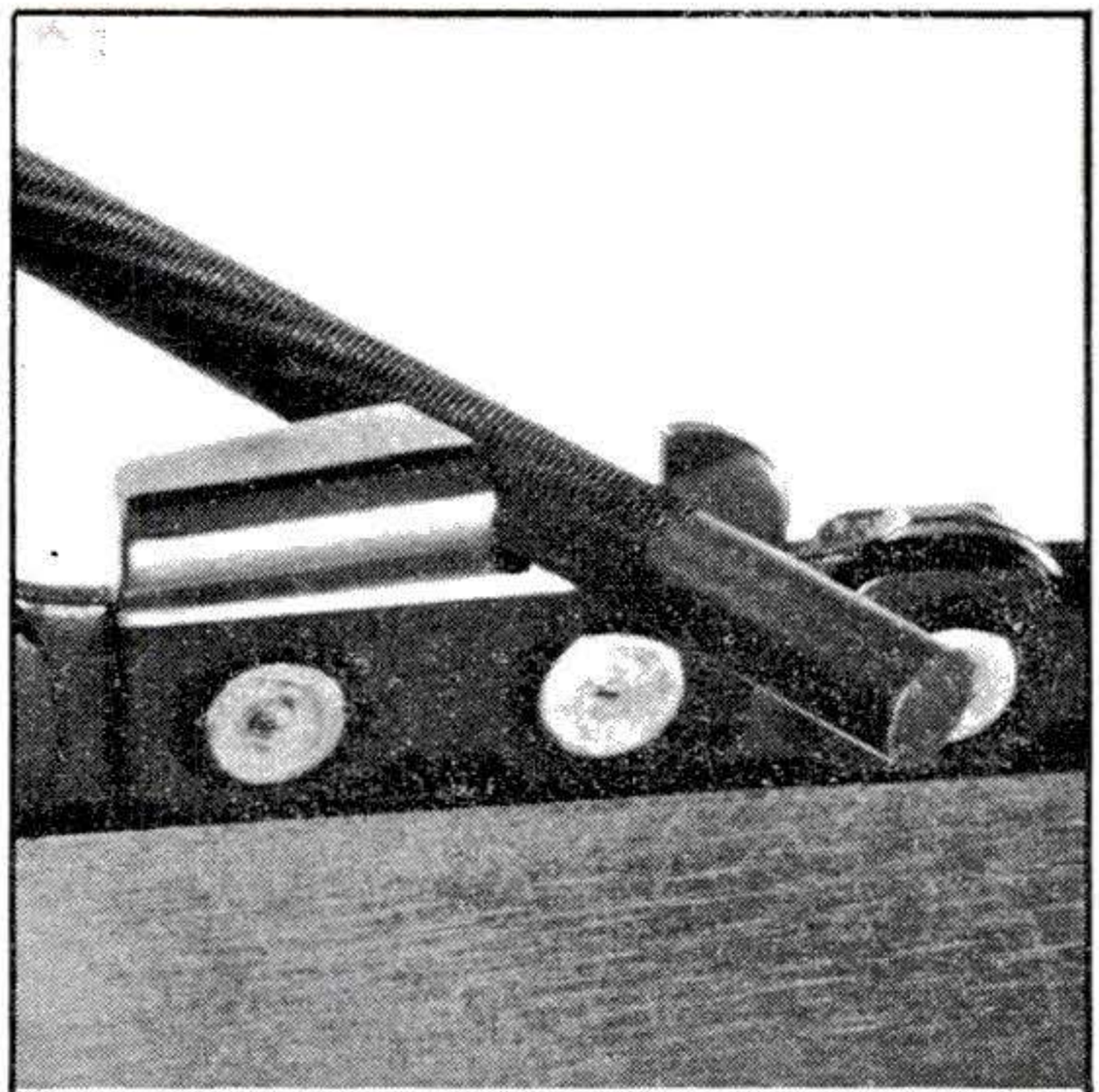

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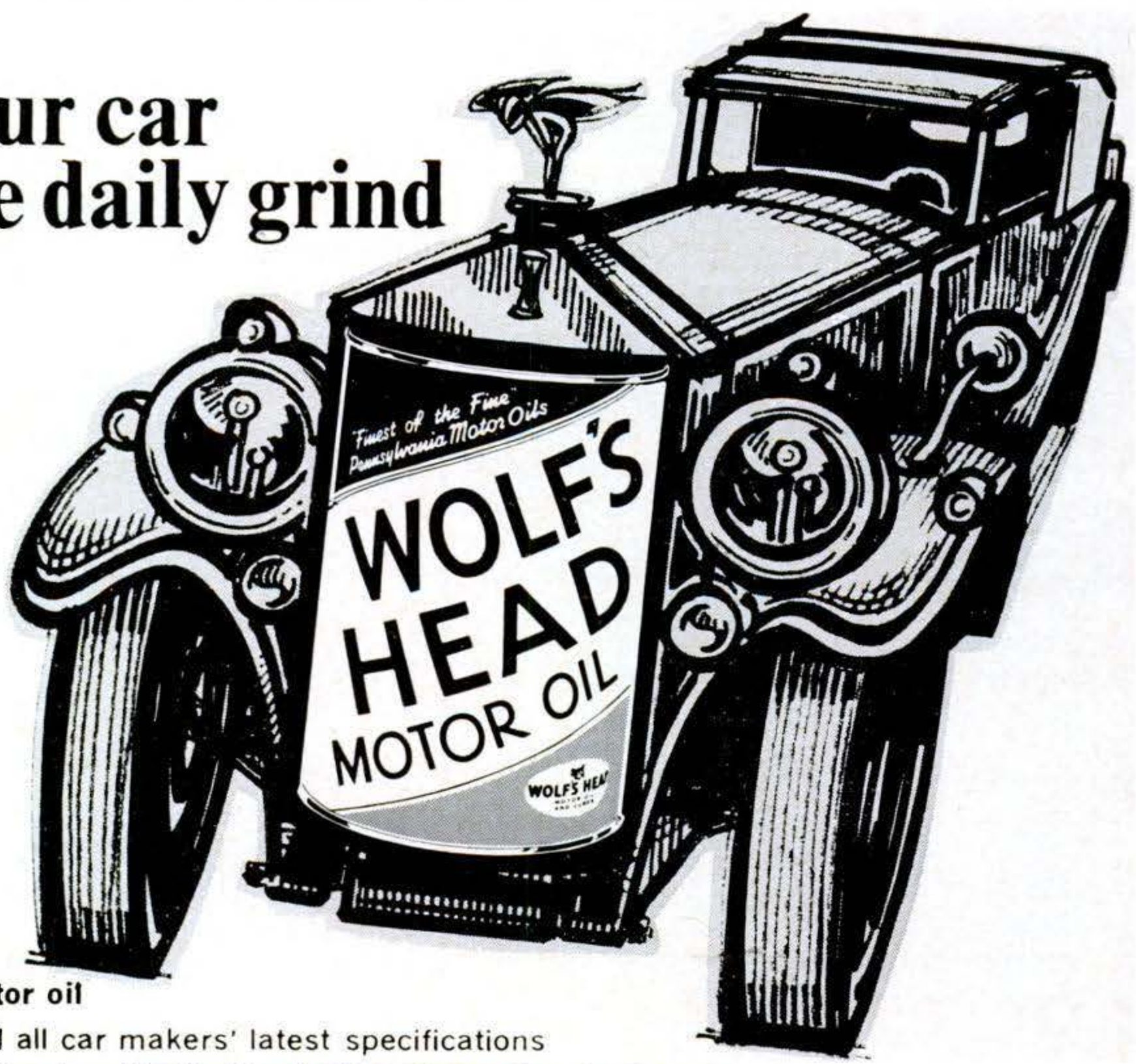

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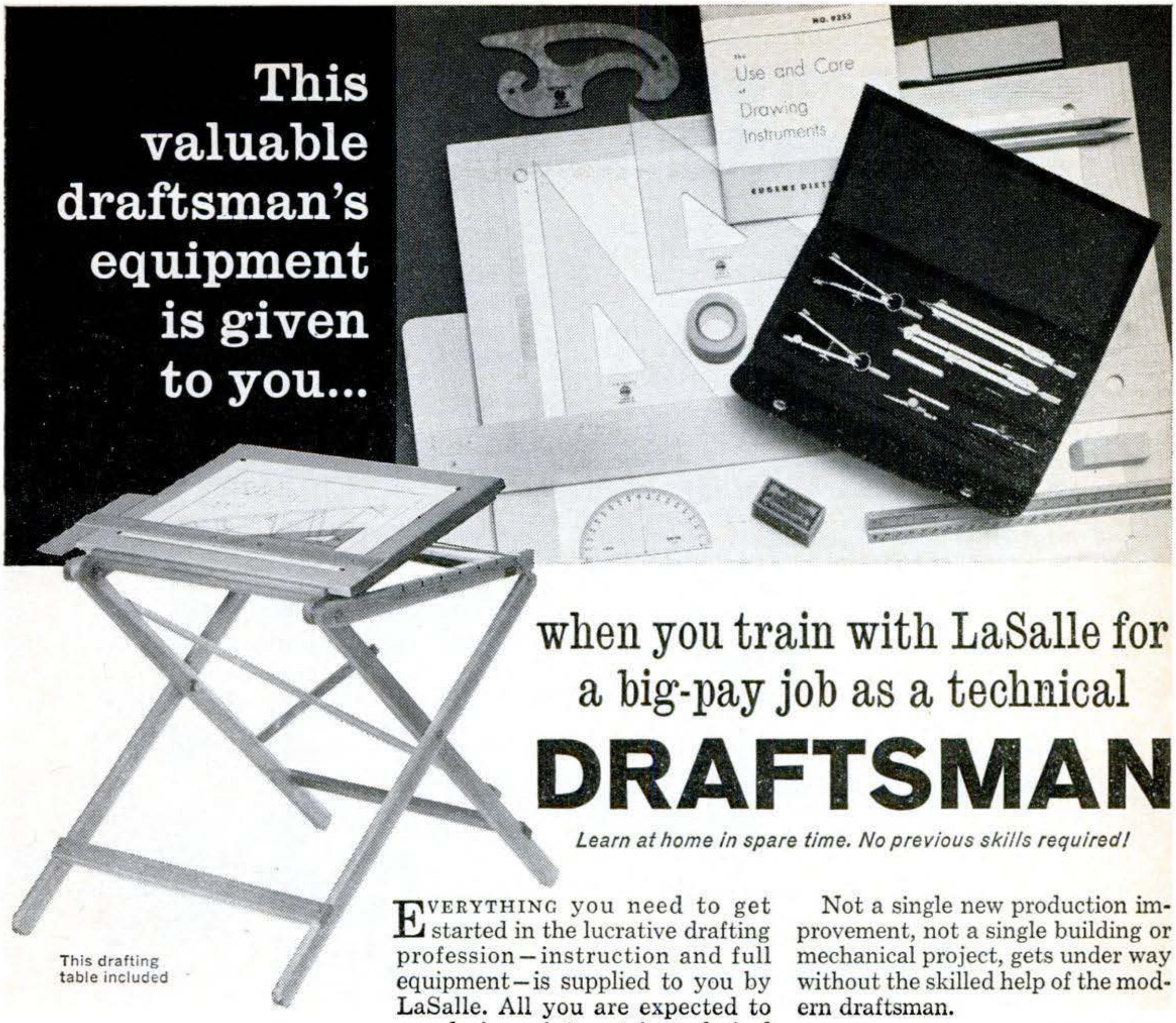

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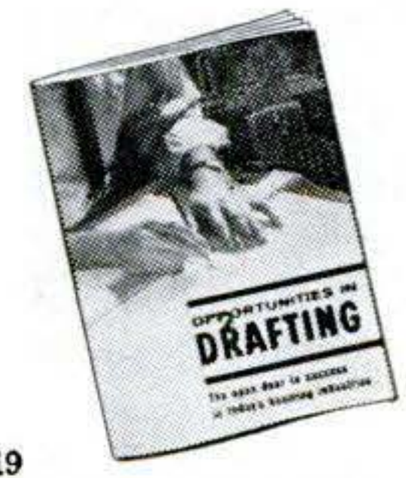

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PS Readers Talk Back

McNamara's Missile Defense

Congratulations to PS and Philip Wylie for laying it on the line about McNamara's Missile Defense [Jan]. A strategic fiasco has indeed befallen our country. Once started down the lonesome road toward the "defended posture," we shall find no logical place for turning back. Once we have bought five billions' worth of self-delusion by economizing on everything of tangible value to the country, it will be easy for cost-effectiveness analysis to prove it cheaper to add short-lived fix-its than to junk the whole dangerous, arms-race-stimulating, planned-obsolescence mess.

McNamara seems to have fought ABM procurement tooth and nail, but was apparently overruled by the President.

T. E. PHIPPS JR., McLean, Va.

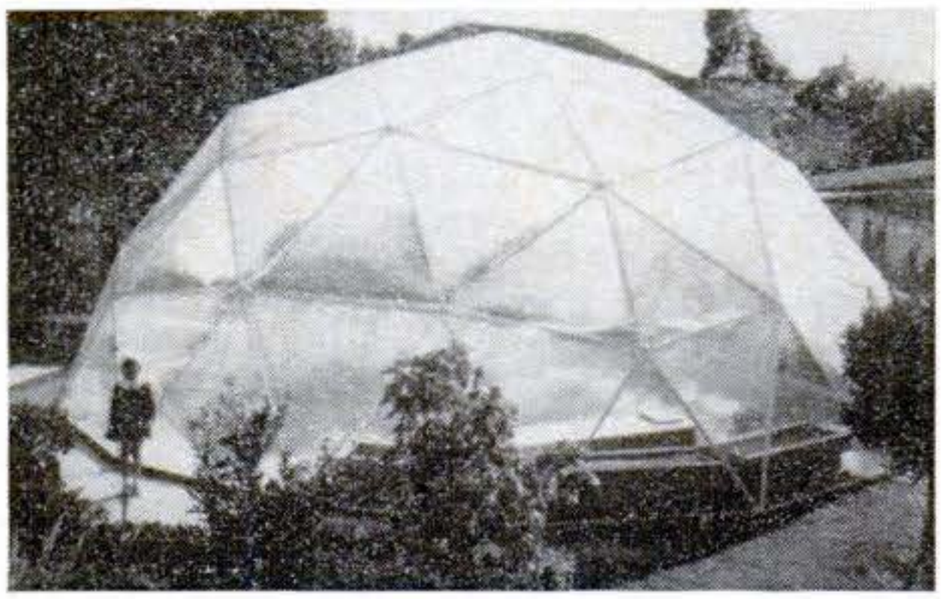
Praise for compact darkroom

Your "Compact Darkroom" [Jan.] is great! Our Cardinal McCloskey High School is using its ideas to develop a newly formed darkroom. Your article came at precisely the right time. Thanks.

KEVIN SLEASMAN, Albany, N.Y.

A dome to really be proud of

I bought your plans and built a geodesic dome [May '66] to cover my pool. I needed a dome about 35 feet in diameter, so I enlarged the dimensions of the 30-foot plan by



1.15. I used Philippine mahogany, which is stronger and clearer than clear pine and costs only slightly more. The staples were special-order 9/16 bronze. The covering is four-mil vinyl. Thank you for a good project.

BRUNO V. MISEVIC, San Pedro, Calif.

Space voyaging in the Enterprise

"TV's Star Trek" [Dec.] answered a lot of my questions about the show. I agree with Mr. Asimov that it certainly is the most scientific science-fiction series ever to come along. I hope it remains on TV for years to come.

TONY DUPLECHIN, New Orleans.

A hot item hits the deck

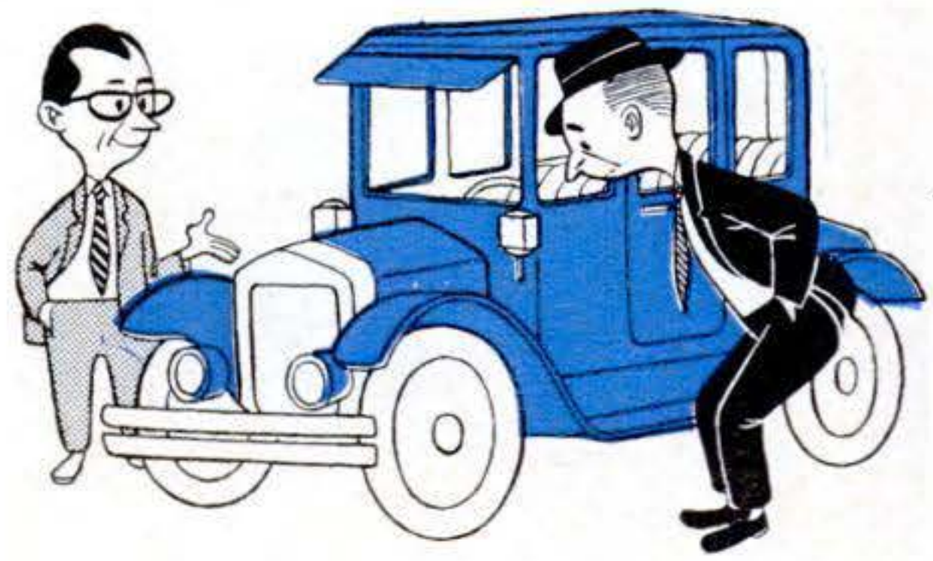
The silent-trolling-motor project ["Two for Your Outboard," Jan.] could give the builder some trouble. Your wiring drawing would put the male connection on the battery side. If it accidentally disconnected and fell on a metal boat, the fire could really fly. I put the male connection on the motor side so it is not hot when disconnected.

M. R. HUDSON, Neosho, Mo.

Right you are. We've slapped our artist's brush hand. Definitely the female connector should go on the battery and the male connector on the motor.

Zeroing in on odometer cheats

"I'll Cheat You if You Don't Watch Out" [Dec.] reminds me of a local Cadillac dealer who isn't bashful. He turns all his used



cars back to zero mileage and still asks top prices for them. When asked about their original mileage, he dismisses the question with, "They're suburban-driven," or "We're not claiming they're new." Apparently he does very well under the respectability of his dealership and the appeal of a neat row of zeros.

RAYMOND C. KODLEC, Brookfield, Ill.

Five-cylinder outboards

In "Testing the Biggest and the Littlest Outboards" [Jan.], Jim Roe says no one has yet produced a five-cylinder outboard. Cross Gear & Engine Co. built a 50-hp. radial five-cylinder outboard in 1929.

HORACE P. ABBOTT, Old Greenwich, Conn.

A blast at imports

PS is published primarily for Americans, and at least 90 percent of Americans still buy American autos. How then do you justify your Automotive Editor, Jan P. Norbye, whose bias in favor of small imports is

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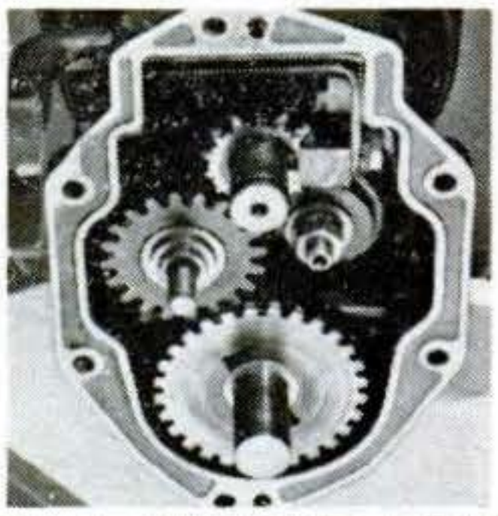

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PS Readers Talk Back

[*Continued*]

not only obvious, but ludicrous? In issue after issue, he picks nits off versatile, soundly engineered Detroit products while drooling with delight over machines, like the Fiat Dino, which are about as useful to the average American motorist as turbofan-powered nail polishers.

Surely, it isn't impossible for PS to find a motoring journalist who is interested in all types of cars and can look at them in an objective, level-headed manner.

R. W. REES, Orange, Tex.

Do not-so-average-American car buffs have anything to say?

Missed our target

One of your resident gremlins mixed up the captions [Jan., p. 93] identifying the weapons in my article on the new air rifles. Here are the correct identifications, reading top to bottom: Hy-Score Model 810, Weihrauch Model HW55-SM, Walther Model LGV, Anschutz Model 250, and Daisy/Feinwerkbau Model 150.

The Anschutz has an 18½-inch barrel, not 18¼-inch, and costs $175.

PAUL WAHL, Bogota, N.J.

Our apologies to author Wahl and the readers who spotted this error.

Want to get something off your chest? Write "Readers Talk Back," POPULAR SCIENCE, 355 Lexington Ave., New York, N.Y. 10017.

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You can make most u-turns in one clean sweep.

4-wheel independent suspension

Each wheel moves up or down without affecting all the other wheels. So when one wheel hits a bump, only one gets bumped. The other 3 keep the car and you going in a level position.

4-speed synchromesh transmission

This matches the speeds of the engine and transmission to allow the gears to mesh easily. Which makes shifting a lot easier on you and your transmission.

Replaceable wet cylinder sleeves

When the cylinders wear out in a conventional engine, the whole engine has to be pulled out and rebored. Sometimes it pays to buy a new car. But a Renault piston moves in a replaceable wet sleeve. If the sleeve ever wears out, you can put in a new one easily and inexpensively.

Sealed liquid cooling system with expansion tank

Water-cooled engines are much quieter than air-cooled engines. However, water and anti-freeze can frequently overflow. But Renault's water-cooling system has an expansion tank to keep the overflow from escaping.

5 main-bearing engine

Instead of three bearings supporting the crankshaft, we have five. (As many as most V-8's.)

Special vents for draft-free ventilation

You can get plenty of fresh air with the windows shut. Which, incidentally, shuts out noise.

Rack and pinion steering

Eliminates play in the steering.

2-speed hot-water heater and dual defroster

Our heater uses the same hot water that circulates in the engine. So our heater heats faster and produces a more even temperature than any air-type heater.

15 inch wheel

Most economy cars have 13″ or less. Our larger wheel makes fewer revolutions to go the same distance. Which saves rubber. Which saves money.

Spare tire not in trunk

If you get a flat you don't have to unload the trunk and get everything dirty.

11 cubic foot trunk capacity

We're not the biggest in this department, but neither are we the smallest. The smallest only has 2.3 cubic feet, which is about as much space as we have behind our back seat alone.

Hits a top speed of 85

That's pretty surprising considering the mileage we get.

Unique warranty

12 months/unlimited mileage.

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Naked Power

Size for size, this new, more powerful Sears DieHard gives you 35% more usable starting power than the best battery anyone else makes.

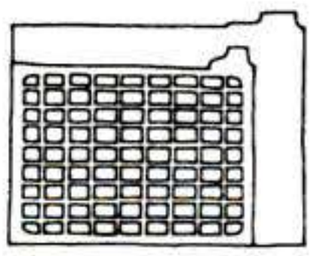
This is not the DieHard you have been reading about. (The most powerful car battery of its size in America.)

This one is even more powerful and you can see through it. With a battery this good we have nothing to hide.

The DieHard began with a thin-walled case. For more room inside. We started out by putting in higher plates, and more acid.

Now we've found we can make the plate wider as well as higher.

At first glance a few square inches may not look like much. But this is a 78 plate battery. So when you add it all up you get an extra 680 square inches of plate area in contact with the battery acid.

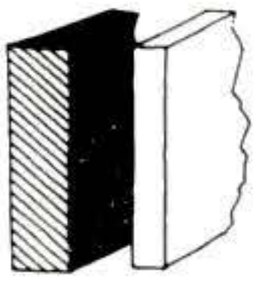


The high, wide plate

And that produces a lot of extra power.

This is no ordinary advertising claim. We aren't giving you an inch and calling it a mile.

We are giving you 35% more usable starting power than the best battery of its size made by anyone else in the business.



Thinner but stronger.

Try that out on a balky engine some freezing morning and see what we mean.

If you want to thank something, thank polypropylene. This weird sounding plastic is one of the leading miracle materials in an age of miracle materials. Even with 50% thinner walls, it is far stronger than the old black battery case ever was.

At zero degrees, it is 60% stronger. At normal room temperature, it is six times stronger. And after exposure to 200 degrees (check the temperature under your hood on a hot day) it is a fantastic forty times stronger than the old-type black rubber battery case.

So we did something else to the new DieHard. To make sure you know you're getting the strongest battery case there is—the polypropylene case—we left it the natural color of polypropylene.

A handsome off-white. A sort of milky color you can see through. If you look close you can see the plates. And the acid.

You can also see when your battery needs water. And if this helps you take better care of your DieHard, that's fine with us.

Because we guarantee the DieHard for five long, happy years. And when Sears guarantees, Sears guarantees.

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America's most powerful car battery
Sold only at Sears. $29.95 with trade-in.

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The DieHard is so new it's available in Group 24 only. This size fits most Chevrolets, Chryslers, Dodges, Plymouths, Studebakers, many Oldsmobiles and Pontiacs, all Ramblers and Willys. Soon it will be available in all popular sizes. Sears carries a complete line of other fine batteries as well, in a wide range of prices.

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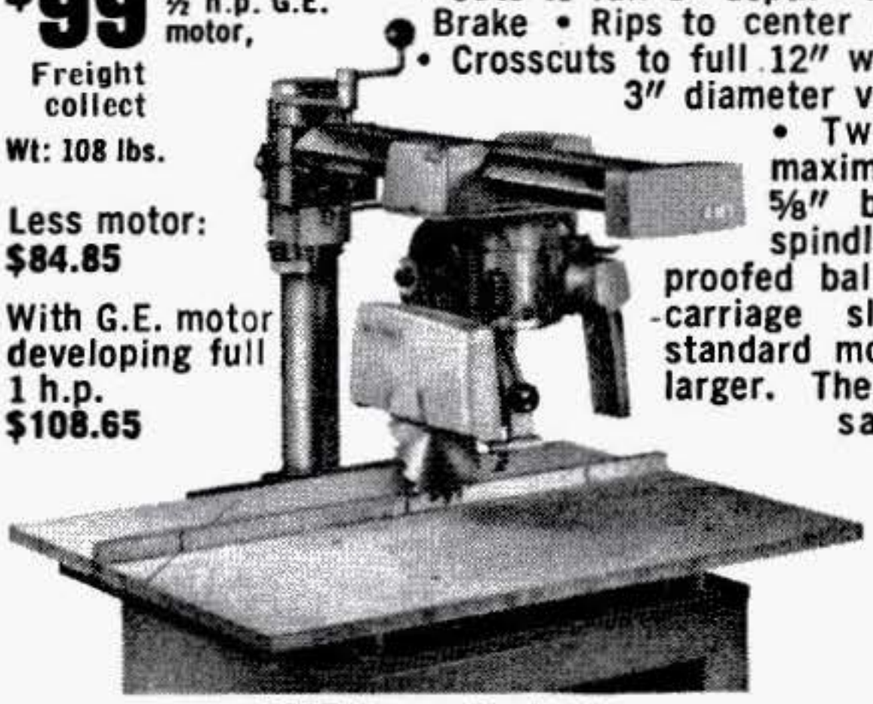

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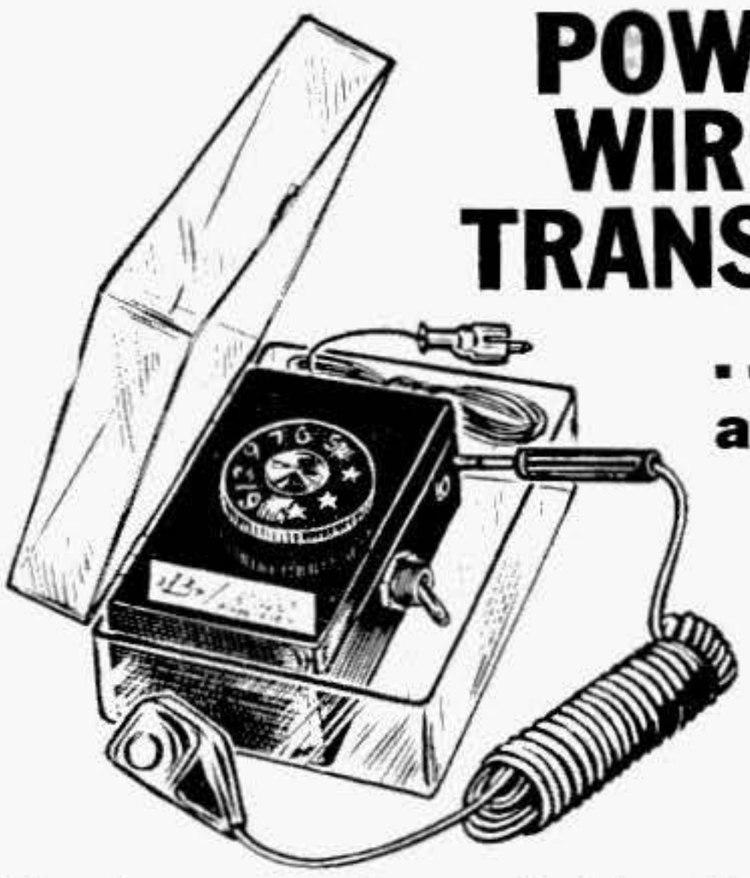

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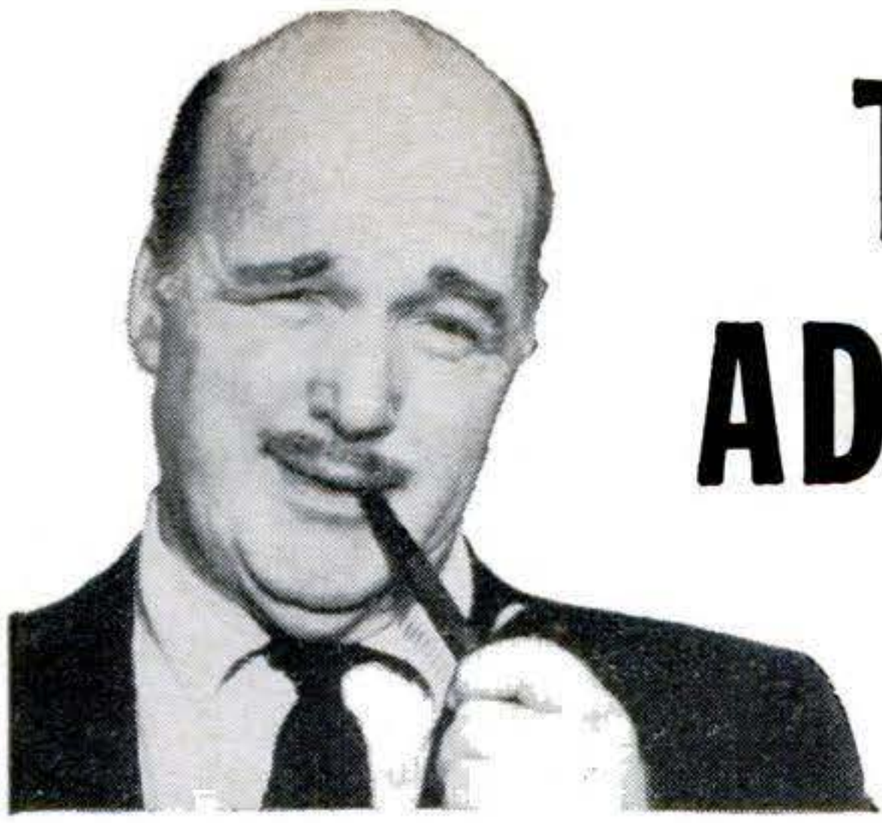

TOM McCAHILL ADVISES SATURDAY MECHANICS

If you're a Saturday mechanic, my guess is you can fix the screen door, build lawn furniture, overhaul the kid's bike, and rotate your own tires.

It's a different story when that fancy electric coffeemaker stops perking or the push-button automatic washer quits halfway through a cycle. You might spend an afternoon admiring the coffeemaker's innards before giving it a permanent vacation on the top kitchen shelf.

As for the automatic washer, after the Little Lady shouts "Do something!" you'll end up phoning an Appliance Serviceman across town. He shows up in 3 days and has the washer going in one-fourth the time it took you to study the coffeemaker. He also presents you with a ticket for 30 bucks. When you consider he could make twice that selling you a new machine, you got off easy.

Maybe you never realized it, friend, but you have more Appliances around your hacienda today than you did five years ago. If you count power tools, your wife's hair dryer, an air conditioner, plus the standard stuff like vacuum cleaner, toaster, refrigerator, freezer and so forth, you probably have well over a dozen.

These electrical gadgets nowadays represent a pretty good chunk of your hard earned dollars. Did you ever stop to think it could pay you in savings and convenience to know how to fix these things? Also, it could be a great source of extra income if you're inclined to tackle the few thousand broken Appliances right in your own neighborhood.

The Appliance Repair business is easier to learn than you imagine. The National Radio Institute's Appliance Division has a downright interesting, low cost course you can take in your spare time. It covers every type of Appliance you can think of plus air conditioning, refrigeration, house wiring, electric motors — even small gas engines. There's a worthwhile section on farm and commercial appliances too.

NRI starts you with the basic principles of electricity to give you a solid background. Using clear-cut picture diagrams, they show you how various types of Appliances work, separating each into groups. Included with the course is a topnotch, professional Appliance Tester for fast troubleshooting.

Easy to read, bite-size lessons are loaded with photos and cutaway drawings so you see how each Appliance comes apart, and more important — goes back together in working order.

Whether or not you agree that knowing Appliance Repair could help you, I recommend you see for yourself. The coupon below will get you a free book that fully describes this unique home training. No salesman is going to call.

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Tom McCahill

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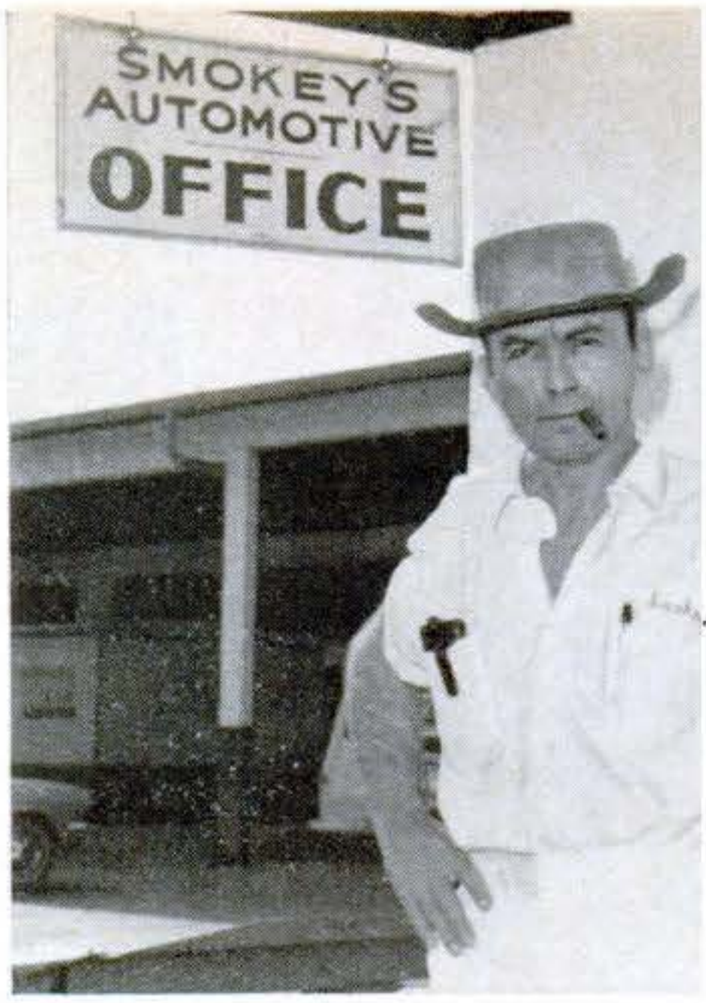
"Say, Smokey—"

A clinic on cars by America's most famous mechanic

Each month in POPULAR SCIENCE Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Ask Smokey. You'll find the address at the end of the column. Please *print* your name and address.



"What can I do with my '63 Cadillac engine that builds up carbon on the underside of the intake valves? It has an oil change (10W-30) each 3,000 miles, and with 40,000 on the odometer still uses only about a quart between changes. I get good gas mileage."

PERRY E. GROVE, Chehalis, Wash.

The valve guides probably are loose, and oil runs down to create most of your carbon. Put on P.C. valve seals. Make sure the exhaust system is in good shape. It's important to use the grade of fuel and oil that the factory recommends. Check the crankcase vents, automatic choke, and timing to wrap up your fix. And a tip: If you'll get out on the superhighway once in a while and drive the speed limit, you'll burn out some of those deposits.

"We have a form of auto racing here, not unlike sprint racing, except that we don't have fuel injection, quick-change gears, etc. We permit engine modifications, including changes in lubing, ignition, and carburetion; porting and polishing; and a choice of cams. The B class, for which I'm going to build, includes any six or flathead V-8. I'd like to modify a 308 Hudson and would appreciate a few tips. In bygone days you were one of the country's foremost Hudson setup men."

RUSS CRAWFORD, Great Falls, Mont.

Frankly, you start with a debit—an r.p.m. of 5,500 would be tops for the Hudson engine. That isn't too good. Better not push it beyond 5,000, in fact—the oil system is borderline. To describe all you might do to improve the performance would be beyond the limits of this column. Try to find a 7X-308, and start from there. Two single carburetors would be best, but you could try a homemade, single four-barrel. Those engines have a lot of torque, but they're also heavy. Best of luck on your project.

"At speeds over 65 m.p.h., I have absolutely no brakes in my wagon, a '65 Olds Vista Cruiser. The power unit, drums, and linings have all been checked out. Even a specialist brake mechanic is stumped. Yet under 60 m.p.h., I can stop on a dime."

JIMMY CANGENE, Hallandale, Fla.

Jump a vacuum gauge into the supply line of the power-brake unit, then run the car at 65 to 70 m.p.h. I think you're going to get a zero reading. You'll probably find your trouble in the vacuum supply. Also, make sure that the side of the power cylinder vented to the atmosphere is not being restricted by something that is occurring only at higher speeds.

"I'm doing a soup-up job on my '64 Plymouth 318-cube V-8 rated at 230 hp. with two-barrel carburetor. I'm having the heads milled, ports polished, cylinders rebored, and larger pistons and bigger head gaskets installed. What would be best for weekend racing—two four-barrel or four two-barrel carbs?"

JOHN MCELROY, Nashville, Tenn.

Better stay with a *single* four-barrel until you get some experience. Double four-barrels would be indicated here, but while they usually put out more power, they can really get you talking to yourself until you get them just right.

"My '66 Chevelle Malibu with the 283 engine sits with the front end way up and the back way down. When I put as little as

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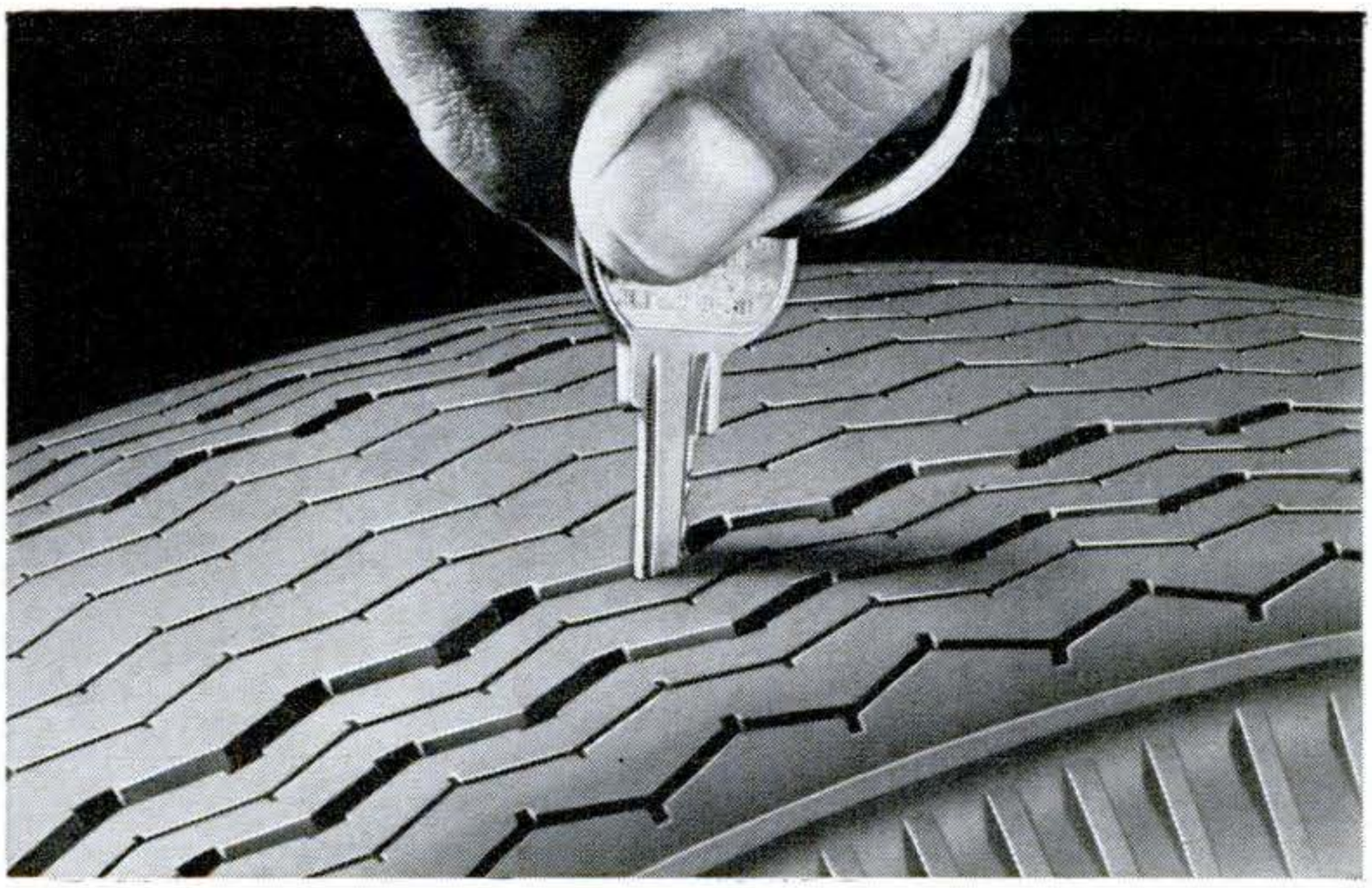
The Round Tire is Tread-ier



It gives you at least 3,000 extra miles

What do we mean by "tread-ier"? Just this: The Round Tire—Atlas Plycron*—has a rugged overall construction that's topped by a muscular tread made of tough, long-lasting rubber compounds.

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Road tests against complete sets of tires for new 1968 cars again proved that the Atlas Plycron is "mile-ier," too. It will give you at least 3,000 more miles than tires that come on most new cars. Do we test Atlas Plycron tires for safety? You bet. Fifty-four different ways. You can't buy a more reliable tire. Get Atlas Plycron tires and start thousands of miles ahead!

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"Say, Smokey—"

[*Continued*]

75 pounds in the trunk, the back end squats so much it feels like it's fishtailing when driven. The Chevrolet dealer tells me that all cars of this model do the same."

CARL B. KIRK, Mobile, Ala.

Nonsense! Get some new rear springs. Contrary to the dealer's soothing-syrup talk, this car should sit a little nose-low when empty. Check your front springs, too.

"By adding three two-barrel carburetors, I'd like to modify my 1964 GTO, with a four-speed box and Positraction, to get 360 horsepower. What should I do in order not to place undue strain on the power plant, yet get the maximum?"

STEVE MARTIN, Reedley, Calif.

Seems like everybody wants to fly without wings this month. My advice is to leave your GTO alone. But since you probably won't take it, here's how to do the job: When you change the three two-barrels, get the camshaft, exhaust system, and all other parts Pontiac uses in its 360-hp. engine. There are no short cuts and no back-yard engineering you can use.

"Ever since I bought my '66 Barracuda V-8 I've had an exhaust smell in the passenger compartment. It's there with windows open and vents closed, but not with vents open and windows closed. The dealer, now out of business, didn't help, nor have several garages. The exhaust system seems to check out all right. A new muffler and a longer tailpipe were installed, to no avail."

JAMES RASKA, Junction City, Wis.

The air-flow patterns around and into a car are complex. Have you ever asked yourself why the rear window of a station wagon gets so dirty? I think your problem is air flow that picks up exhaust gases. I'd write to Chrysler for a fix. Barring that, have a local garage experiment with tailpipe location. Trial-and-error should solve your problem.

"My father's '66 Galaxie, with 289-inch V-8 and two-barrel carburetor, falters and loses power for about two seconds on sharp right turns at about 25-30 m.p.h. The dealer says, 'It's the nature of the beast.' Could he be right?"

JIM CHARLTON, Preville, Que.

No. But could it be that you are doing a little amateur sports-car driving when Dad's not looking? See if you can talk him into buying the Holley carburetor for that model, the one with the floats running fore-and-

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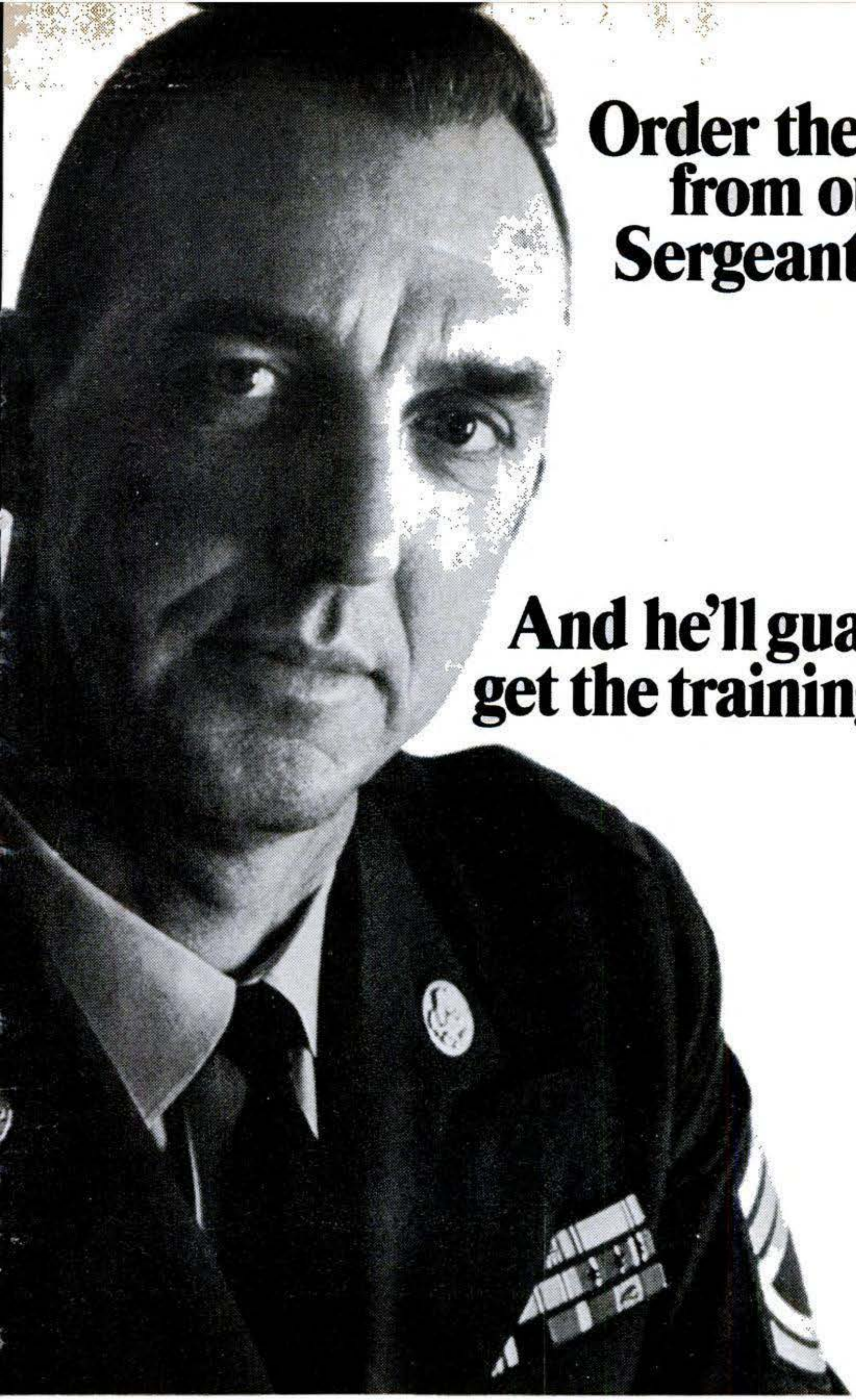

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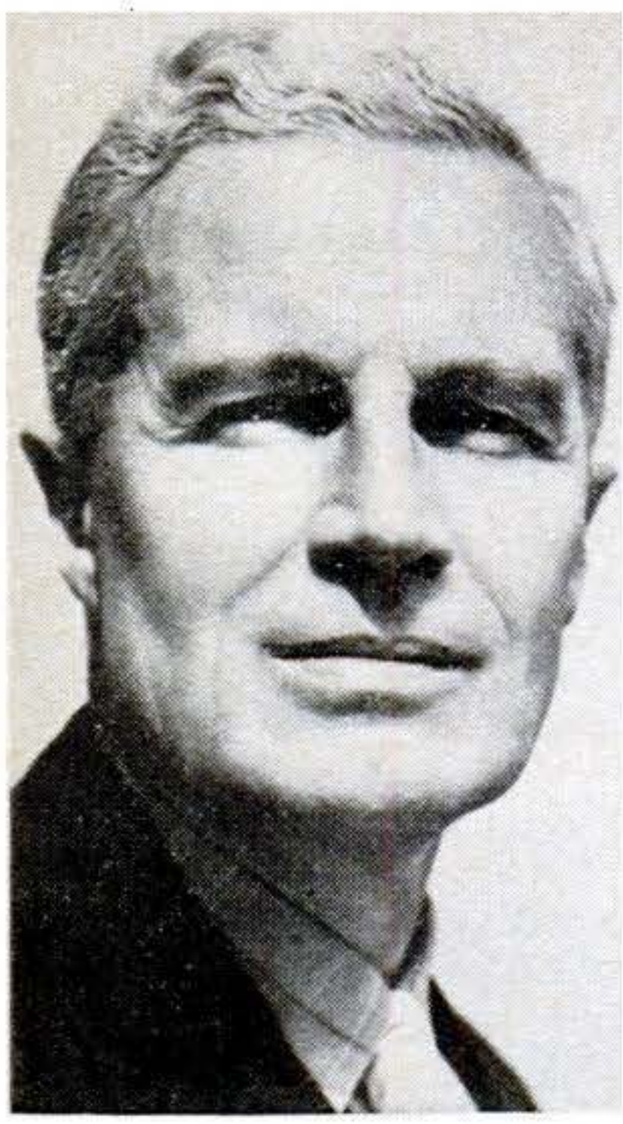

I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be — today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my summer home, my Cadillacs, my winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to levels of independence beyond the dreams of avarice.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things, of innumerable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish!* And anyone who tries to tell you that you can *think* your way to riches without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned!* I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. And, in addition, I have the satisfaction—the deep satisfaction—of knowing that I have put more than three hundred other men in businesses of their own. Since I have no need for money, the greatest satisfaction I get from life is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to gain his position. And, unless you are willing to make at least half the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the secret I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

I have a business that is peculiar—one of my businesses. The unusual thing about it is that it is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that it is within the reach of anyone who has a television set. But it has nothing to do with television.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined?

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will keep your "factory" running 24 hours turning out a product that has a steady and ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in becoming your own boss, in knowing the sweet fruits of success as I know them, send me your name. That's all. Just your name. I won't ask you for a penny. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest $15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about the business I have found to be so successful. After that, you make the decisions.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in the kind of independence I enjoy. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness and prosperity to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you will not cost a penny, now or at any other time.

VICTOR B. MASON
1512 Jarvis Ave., Suite M-3-CO
CHICAGO, ILLINOIS 60626

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CUT ANY MATERIAL with Naval Super-HACK Blades

As low as $1.60 ea.

Naval Carbide Drill Bits for glass, steel, etc. in diam. 1/16" and 1/8" for $9 and 1/4" $16 ppd.

Rip thru hardest metal (a file) in less than 2 minutes. Cut even curves or notches in materials formerly considered unsawable . . . like glass, glazed tile, bricks, tool steel, marble. Very little effort. This famous cousin of the diamond, furnace-born tungsten carbide, now joins the rod saw blade. Fits any hacksaw. Only $2.79 for one blade, 3 for $6.20, 6 at $2 each (total $12) ppd.

MEREDITH, Dept. PS-3, 310 West 9th St., KANSAS CITY, MO. 64105

$50 REWARD

for Any Spider, Bug, Insect that Bugmaster Electric Units fail to kill. Here is your automatic, odorless electrical way to rid apartment, home, office or plant of disease carrying bugs, roaches, fleas, bedbugs, ants, moths, silverfish.

KILL BUGS INDOORS

THE INSTITUTIONAL WAY

- ☐ Model H—$9.95 plus 75¢ p&h
- ☐ Xtra Crystals for H –75¢ per box
- ☐ Model G—$15.95 plus $1 p&h
- ☐ Xtra Crystals for G—$1.50 per box

Model H—6,000 cubic feet
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☐ **Pkg. Chlorophyll Odor Kill Crystals 75¢**

When Ordering refill crystals only please add 40¢ pstg. & hdlg.

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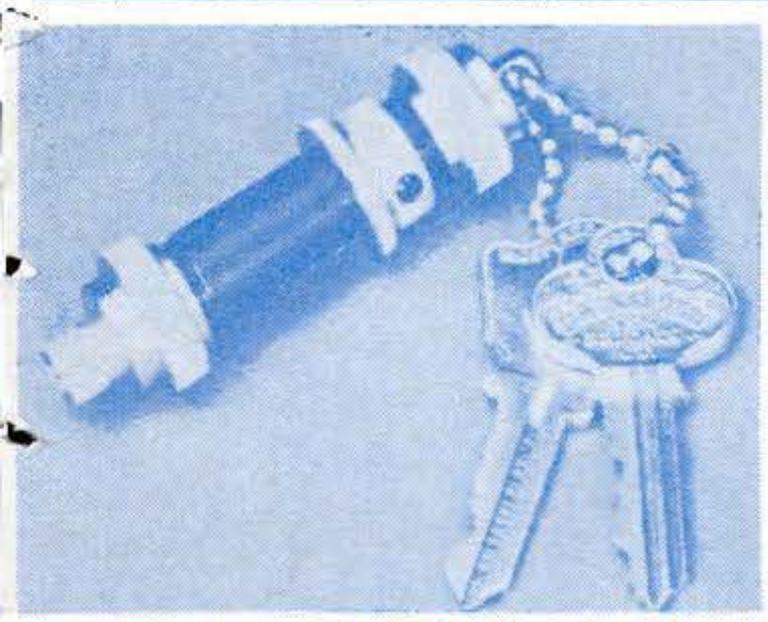


Secret Tear Gas Ornament

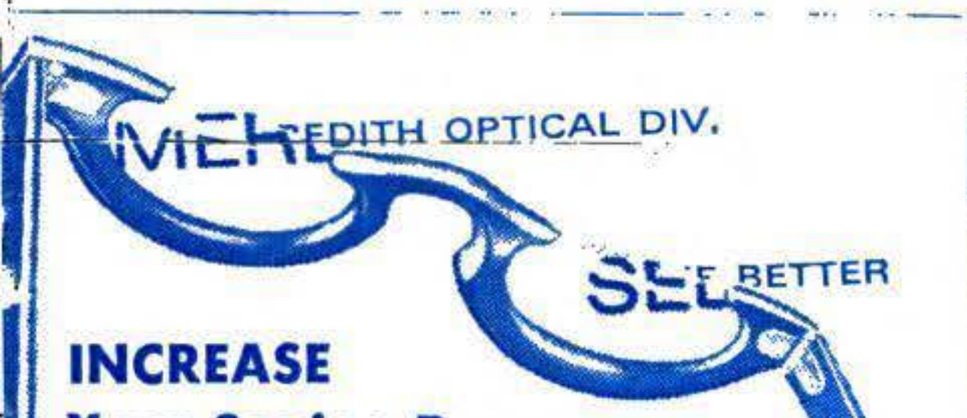
looks like a tiny key chain gimmick, made for British Secret Service, blasts a wide spread 38 cal. charge of the new McNamara Choice Tear Gas (CS—stun gas)—a real professional, safe, completely secret device that stops an aggressor in his tracks, renders him utterly helpless instantly but is harmless (he recovers in an hour). Precision machined from steel and brass, will not fire accidentally, requires no license or permit. Complete with 2 38-cal. shells, one talcum powder practice shell. We pay all shipping costs anywhere in USA. $16.50 —3 for $12 ea. (total $36.00). 6 for $10 ea. (total $60)

MEREDITH, Dept. PS-3, 310 West 9th St., KANSAS CITY, MO. 64105

$70 AIR-GUN only $29.95

Complete with chisel this 3 lb. Air-Gun rips into metal, chips concrete, drives pins, etc. Delivers 5500 2" strokes a minute. Operates on 3 to 5 hp compressor. Made especially for govt. and manufacturer made too many. At only $29.95 ppd. while they last, a $70 value. Three extra attachments for exhaust pipe cutting and other uses $9 ppd.

MEREDITH, Dept. PS-3, 310 West 9th St., KANSAS CITY, MO. 64105



INCREASE Your Seeing Power

Franklin-style half-frame glasses with precision-ground lenses. For sharp magnification, just right for most people, frame-top eliminated for unimpeded distant viewing. Black frame is metal-cored, metal hinged, a great value at $4.95 ppd. 3 for $4 each. 6 for $3 each. In 2, 2½ and ~~3 power~~ if you wish to specify.

MEREDITH, Dept. PS-3, 310 West 9th St., KANSAS CITY, MO. 64105

WATCH RUST DISAPPEAR

NAVAL JELLY

is an extremely active new cleaner that removes rust by chemical combination . . . sticks to verticals and overheads. Brush it on, hose it off.

Use on pipes, fences, tools, tanks, all machinery. Eliminates sandblasting, scraping, etc. Easy and quick.

- ☐ 40# @ .65/lb. $26
- ☐ 10# @ 1.50/lb. $15
- ☐ 4# @ 2.00/lb. $8.00

#4 ppd.—other units FOB KC

MEREDITH, Dept. PS-3, 310 West 9th St., KANSAS CITY, MO. 64105

LIQUID PLASTIC

Polyurethane that applies like paint forms a skin so tough it won't crack, chip or peel. Cuts painting costs . . . covers and protects like a shield of unbreakable glass.

WATERPROOF in 30 MINUTES

Adheres to practically anything, stops leaks. Ideal for concrete, aluminum, wood, masonry, canvas, any metal. Clear—any major color. Just specify. $5.95 per qt., $18.50 per gal. We pay all shipping costs. Order NAVAL 5.

MEREDITH SEPARATOR CO., Dept. PS-3, 310 West 9th St., Kansas City, Mo. 64105

Ship as follows: Satisfaction Guaranteed: ☐ Carbide Drills (specify diameter) ☐ Super-Hack ☐ 1 ☐ 3 ☐ 6 ☐ Bugmasters as checked above ☐ Tear Gas Ornaments ☐ 1 ☐ 3 ☐ 6 ☐ Air Guns ☐ Air Gun Extras ☐ Naval Jelly as checked above ☐ Naval 5 ☐ Qt. ☐ Gal. ☐ Reading Glasses (Franklin style) ☐ 1 ☐ 3 ☐ 6 (what power? . . . . .)

Name..... Address.....

City..... State..... Zip.....

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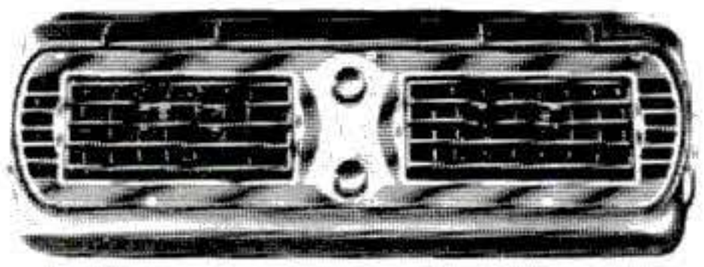
SAVE $200.00

ON AUTO AIR CONDITIONING



NEW LOW PRICES ON COMFY-KIT

Response to Comfy-Kit has been so great we've expanded facilities and streamlined production to build an extra 3,000 units this year. As a result, we're able to lower the price of the Comfy-Kit Standard unit to only $138.00 — the Super unit to just $148.00 — a full $5.00 reduction on each unit!

And that's only half the story. You'll find Comfy-Kit performance is unexcelled. It's expertly engineered to give you years of trouble-free cooling. And . . . when you trade cars . . . Comfy-Kit is easily switched to your new one.

You get a lean, good-looking unit that actually enhances the interior appearance of your car. Compact design leaves you plenty of leg room.

Comfy-Kit is easy to install — takes about four to six hours. That's like being paid $30 to $50 an hour for your time! You get everything you need for installation — even the loan of tools if you need them. You get an easy-to-follow instruction book — and a 12-month/12,000 mile warranty.

Let someone else pay big prices for air-conditioning. Comfy-Kit gives you more efficient cooling for a lot less money (you save $200.00 or more over sticker prices of factory-air).

Join the thousands of other satisfied Comfy-Kit owners. Mail your coupon today and get the jump on the sweltering summer.

EARN UP TO $50.00 A DAY

. . . installing Comfy-Kit units for your friends and neighbors. As an authorized Comfy-Kit dealer, you can make your mechanical skills pay big dividends. Write today for complete information. Or . . . just check the appropriate box on the attached coupon . . . and mail it in.

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Dallas, Texas 75216

☐ Enclosed is $138* for Standard Unit.
☐ Enclosed is $148* for Super Unit.
☐ Enclosed is $30 deposit on a Super ☐/Standard ☐ Unit. I will pay the balance, plus C.O.D. charges when delivered.
☐ Enclosed is $8.00 deposit for a set of four tools, which will be returned to me when I return the tools.
☐ I would like to see the instruction book before I order. I enclose $1.00 for the instruction book only. I understand this will apply on any future Comfy-Kit order.
☐ I would like information on a Comfy-Kit dealership.

Name _____
Address _____
City _____ State _____ Zip _____
My car is a _____ (year) _____ (model)
Engine displacement _____ Horsepower _____
Power Steering _____ yes _____ no
Floor shift _____ Steering column shift _____
Smog pump _____ yes _____ no
*plus state tax where applicable

"Say, Smokey—"

[*Continued*]

aft. Then you can turn the tires off the rims without a gas cutout.

"Recently I repainted my car, using Du Pont Dulux enamel. Having only a single-car garage, I have to let this car stand in the yard under large oak trees. The sap from the trees eats through the paint if not washed off. Constant waxing doesn't help much. Any suggestions?"

PHIL CHAPMAN, Ft. Worth, Tex.

Yes. Put your paint and wax money into some sort of a shelter or cover for your car. Nature still seems to outpaint science. Oak-tree droppings are trouble in the South.

"I get oil leakage from a high-pressure plug on the engine block behind the fan-belt area in my 1966 Chevrolet Impala 327. The car is still under warranty, with about 23,000 miles on it, and I've had it back to the dealer a half-dozen times. A new plug with a liquid sealer hasn't helped. The service manager says that even if he welded in the plug, it would still leak. Did he say that because I'm a woman? Would you use 10-30 all-weather engine oil for this car?"

D. W. LIGHTY, Monterey, Calif.

The only place in the engine compartment of your car that should even get damp with oil is in the timing-cover-seal area. Make your dealer fix the leak. For your locale, use 10W-30 or straight S.A.E. 30.

"With friends, I'm building up a '57 Dodge for dragging. We want to run it as a 'gasser.' What are the safety regulations? Would it be possible to drop a hemihead from a '58 Dodge into it? What size slicks and rear-end ratio should we use?"

PAUL COMERIO, Detroit.

The rules are complicated. Decide whether you're going to run with the National or the American Hot Rod Association—rules differ. And when you begin dragging, you'll find that the rules, as printed, and as interpreted by some of your competitors, often are two different animals. You can drop in the hemi quite easily. In view of all this, I can't tell you what specs to aim for, but a reasonable guess for that car would be a 29-inch tire, low-pressure, 12-inch slick and a 4.88 axle.

Got a question on autos? Send it to:
"Say, Smokey—" POPULAR SCIENCE
355 Lexington Ave., New York, N.Y. 10017.
Not every question may be used. Questions cannot be answered by individual letters.

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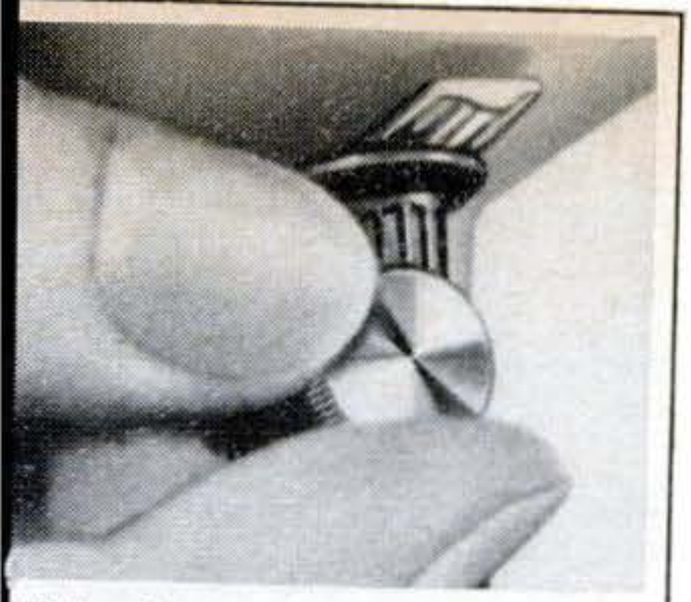
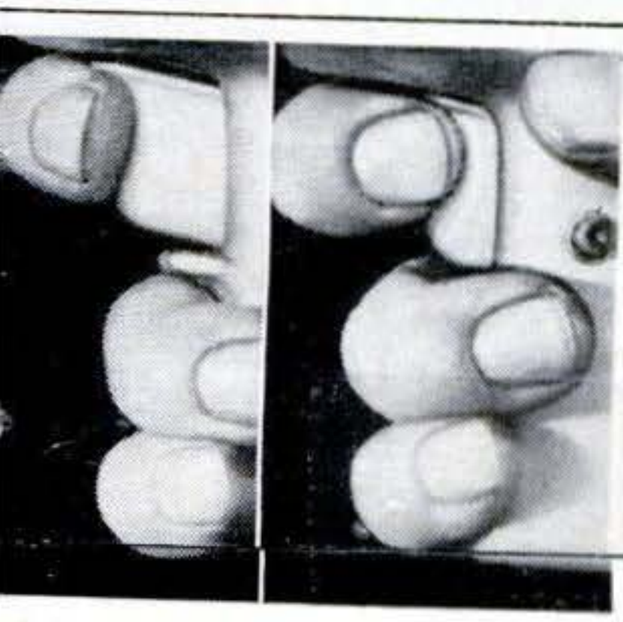


With a turn of the dial,
you preset maximum speed.

New twist

for the world's most useful power tool



et Trigger Speed Control
y varying finger pressure.

ck the switch for forward
reversing action.

l or drive in any material
n perfect control.

Now the Skil Drive-R-Drill comes with adjustable Trigger Speed Control. A special dial built into the trigger *lets you preset any desired maximum speed.* You can't overaccelerate. Result: more control and accuracy on every job. Only the new Drive-R-Drill offers so many features for positive, professional results: (1) the unique dial adjustment to preset maximum speed; (2) Trigger Speed Control to vary speed within the preset range; (3) reversing action that lets you remove screws as well as drive them. See the new Drive-R-Drill with adjustable Trigger Speed Control soon. Available in ¼", ⅜" and ½" sizes.

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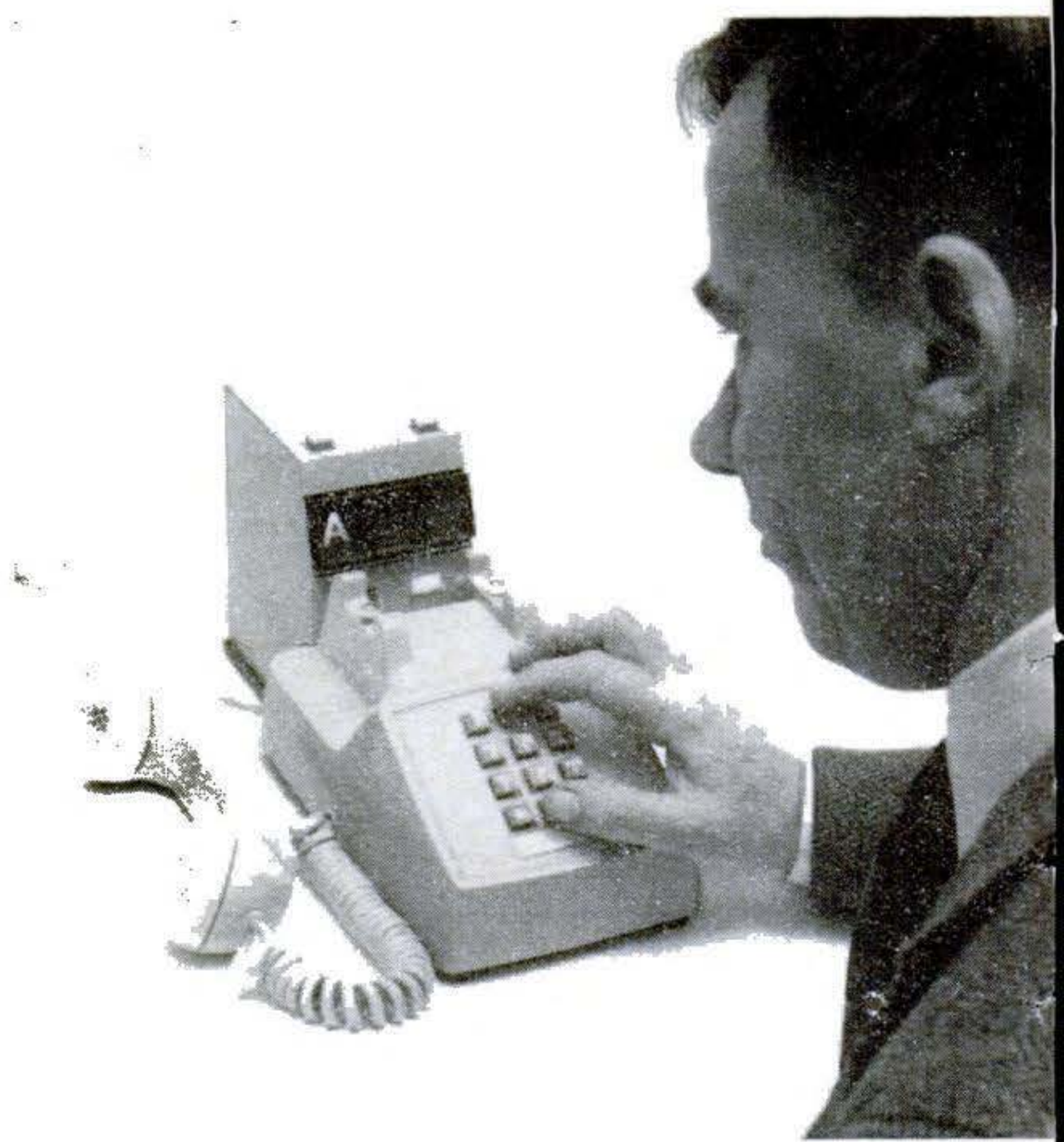
Science Newsfront

Last-minute news and notes to keep you up-to-date

By W. STEVENSON BACON



Flashing letters and numbers make it possible for the deaf to communicate with this simple device being developed by Bell Labs. It works with a Touch-Tone phone following button markings. Pushing "2" once sends an "A," pushing it twice sends a "B," and so on with each button. A switch permits sending numbers, end-of-word and end-of-sentence signals. About eight words a minute can be sent with practice.

Heart transplants as well as the replacement of other human parts may become commonplace with the development of national tissue-typing centers and banks of stored body tissues. The idea is suggested by Prof. Fritz H. Bach, University of Wisconsin medical geneticist, one of many scientists studying tissue typing. Tissue-typing tests developed by UCLA immunologist Paul Terasaki and other researchers were used in recent heart-transplant cases and are believed largely responsible for their success.

Somewhat like blood typing, the procedure mixes white blood cells from the donor with antiserum in up to 350 separate computer-assisted tests to determine what antigens the donated tissue will react against. Similar tests are made with white blood cells from the recipient. When the donor's and recipient's cells show similar reactions (a similar "profile"), chances of a transplanted organ being rejected are much less.

A fold-up airplane that fits in the back of a station wagon was recently patented by engineers at Ryan Aeronautical Co. and may soon be available to the general public. The little one-man machine, originally designed to be parachuted to downed pilots, weighs just 175 pounds, takes off within 100 feet, and can fly 50-100 miles at 75 m.p.h. Designed by Peter F. Girard and Fred Landgraf, it's quickly dismantled into a half-dozen pieces by pulling a few pins.

The multigrade oil in your car, SAE 10W-30, for example, may not be as effective at reducing engine wear and oil consumption as it should be. Oil with good viscosity at operating temperature is needed. But certain viscosity improvers that are added to some multigrade oils don't seem to do the job. GM research engineers Chester K. Murphy and Paul A. Bennett recently reported that the viscosity added by the improvers may not be as effective in reducing engine wear and noise as the viscosity contributed by the base oil. Also, the viscosities of improved 10W-30 oils may decrease more drastically than expected after the first 500 miles. The researchers conclude only that there is much to learn and that contributed viscosity and base-oil viscosity affect engines differently.

Black light for studying minerals, for toys, theatrical productions, scientific devices, and other purposes can be produced with ordinary light bulbs coated with an inexpensive substance that screens out all visible light. The material, to be sold by Marks Polarized Corp. of Whitestone, N.Y., comes both as a .005-inch-thick plastic foil and as a liquid paint that can be applied directly to fluorescent tubes and low-wattage light bulbs. The material transmits only light between 325 and 400 millimicrons, peaking at 360.

You could see around the curves on two-lane roads with a new system being developed by

Continued

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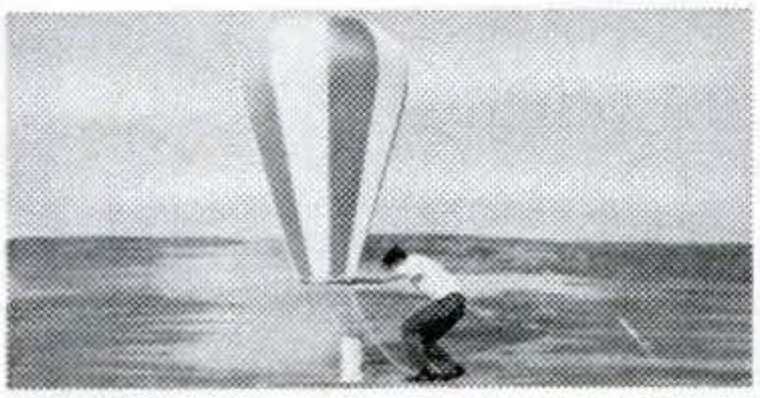
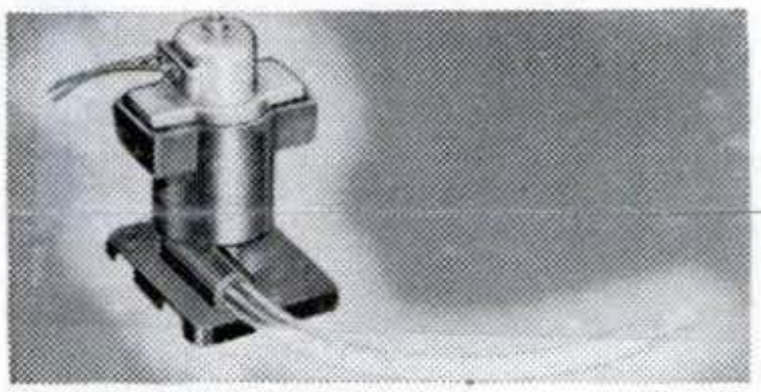
BUILD YOUR OWN ATOMIC ENERGY LAB

Create cosmic ray showers in the cloud chamber—see atoms explode with the spinthariscope—check ionization and radioactivity of every day materials . . . these are just a few of the fascinating projects possible with this amazing 43 part kit. Contains everything needed to construct your personal atomic energy laboratory. Absolutely safe. Includes atomic cloud chamber, projector, illuminator, electroscope, spinthariscope, 22 page instruction booklet with suggested experiments. Ideal to stimulate science interest.
Stock No. 70,899N .....$8.75 Ppd.



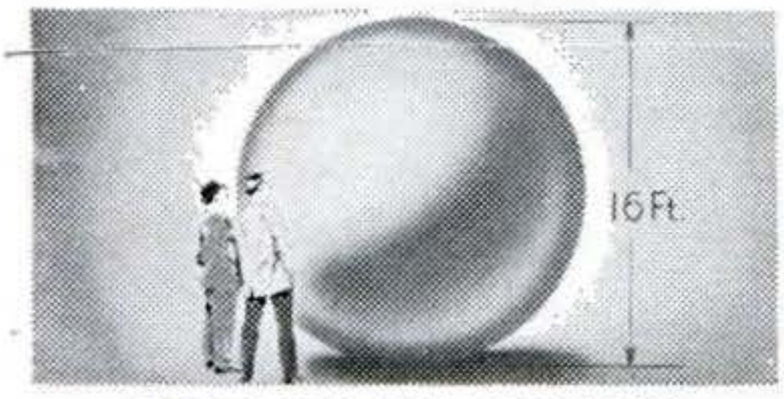
FLY 9-FT. HOT AIR BALLOON

9 Ft. tall. Rises to amazing heights on just hot air. Supplied with tether attached, so can be used over and over. Easy to make, launch, fly. Loads of fun. Great for celebrations, science fairs, plain fun. Will lift model gliders, parachutes, instruments, etc.—anything up to ½ lb. Approx. 5 ft. diam. when fully inflated. Kit contains 10 pre-cut red & white gores (No. 1 model paper), 6 ft. 14-gage wire for bottom ring, top, "tie-off cord.
Stock No. 60,691N.....$2.00 Ppd.



MINIATURE WATER PUMP

Wonderful for experiments, miniature waterfalls, fountains, etc. Tiny (2⅝" x 1¾") electric motor and pump ideal for hobbyists, labs, schools. Pumps continuous flow of water at rate of one pint per minute at a 12" head. With two "D" batteries in series, will pump up to 24" high. Runs 48 hours on battery. Works in 2 directions. Self-priming.
Stock No. 50,345N .....$2.25 Ppd.



GIANT WEATHER BALLOONS

"Balls of fun" for kids, traffic stoppers for stores, terrific for amateur meteorologists. Create a neighborhood sensation. Great backyard fun. Exciting beach attraction. Amateur meteorologists use to measure cloud heights, wind speed. and temp. Made of heavy duty neoprene. Inflate with vacuum cleaner or auto air hose; or locally available helium for high rise.
Stock No. 60,568N (8' diam.) ....$2.00 Ppd.
Stock No. 60,632N (16' diam.) ..$7.00 Ppd.

"FISH" WITH A MAGNET

Go treasure hunting on the bottom! Great idea! Fascinating fun and sometimes tremendously profitable! Tie a line to 5-lb. Magnet—drop it overboard in bay, river, lake or ocean. Troll along the bottom—your "treasure" haul can be outboard motors, anchors, fishing tackle, all kinds of metal valuables. 5-lb. Magnet is war surplus—Alnico V Type—Gov't cost $50. Lifts 150 lbs. on land, under water.
Stock No. 70,571N .....5-lb. $12.50 Ppd.
Stock No. 70,570N .....3½-lb. $8.75 Ppd.

KEEP PACE WITH THE SPACE AGE!

AMAZING BARGAINS

for Fun • Study • Profit
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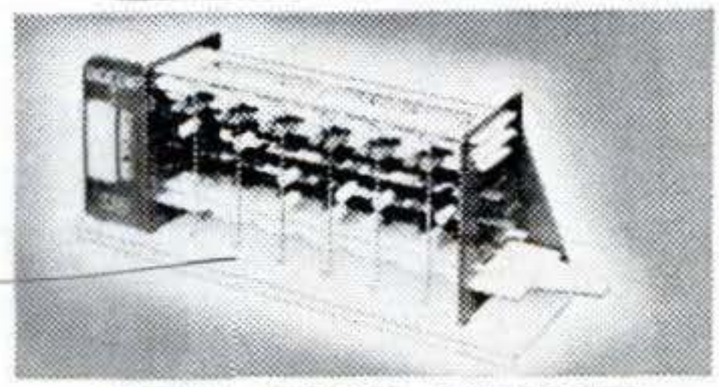
Barrington, N. J. 08007



MODEL DIGITAL COMPUTER

Solve problems, teach logic, play games with miniature version of giant electronic brains! Adds, subtracts, multiplies, shifts, complements, carries, memorizes, counts, compares, sequences. Colored plastic parts easily assembled 12" x 3½" x 4¾". Incl. step-by-step assembly diagrams. 32-page instruction book covering operation. Computer language (binary system) programming, problems and 15 experiments.
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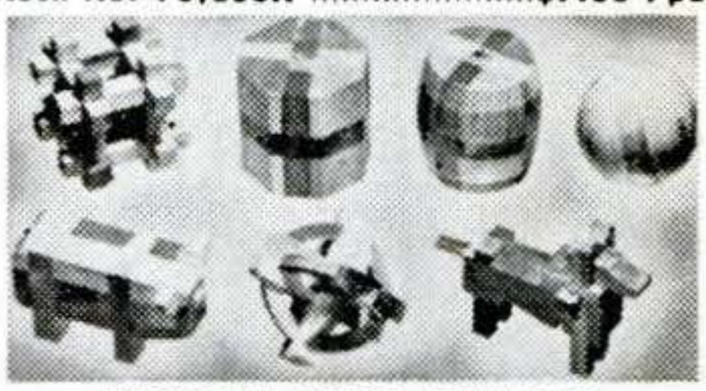
Completely new 1968 Catalog. 148 pages packed with nearly 4,000 unusual bargains. Exciting new categories. Many new items. 100's of charts, illustrations. Many hard-to-get war surplus bargains. Enormous selection of telescopes, microscopes, binoculars, magnets, magnifiers, prisms, photo components, etc. For hobbyists, experimenters, workshops. Shop by mail. No salesman will call. Simply check coupon or write for Catalog "N" to Edmund Scientific Co., Barrington, N.J. 08007.

AMER. MADE OPAQUE PROJECTOR

Projects illustrations up to 3" x 3½"—enlarges them to 35" x 30" if screen is 6½ ft. from projector, larger pictures if screen is further away. No film or negatives needed. Projects charts, diagrams, color or black-and-white. Operates on 115 volts A.C. current . . . 6 ft extension cord and plug included. Operates on 60 watt bulb, not included. Size 12" x 8" x 4½" Wide. Weight 1 lb. 2 ozs.
Stock No. 70,199N .....$7.95 Ppd.



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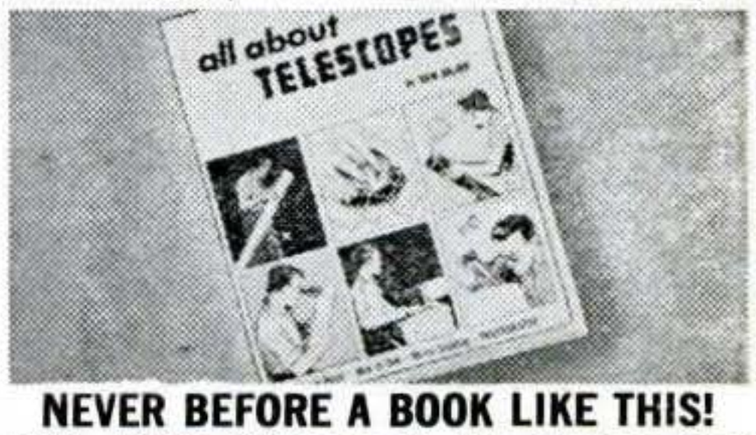

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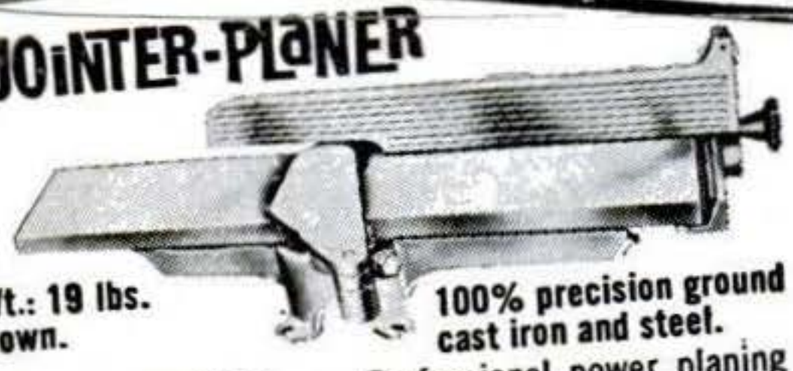

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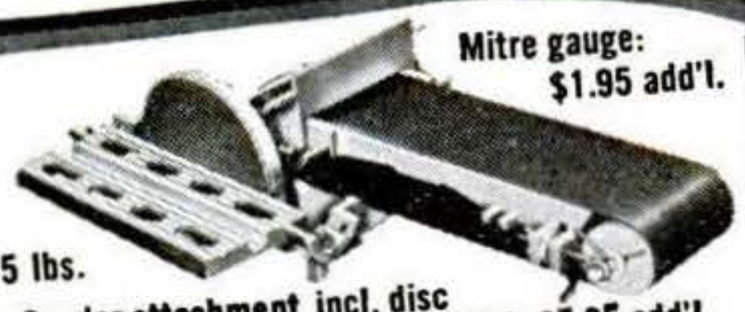

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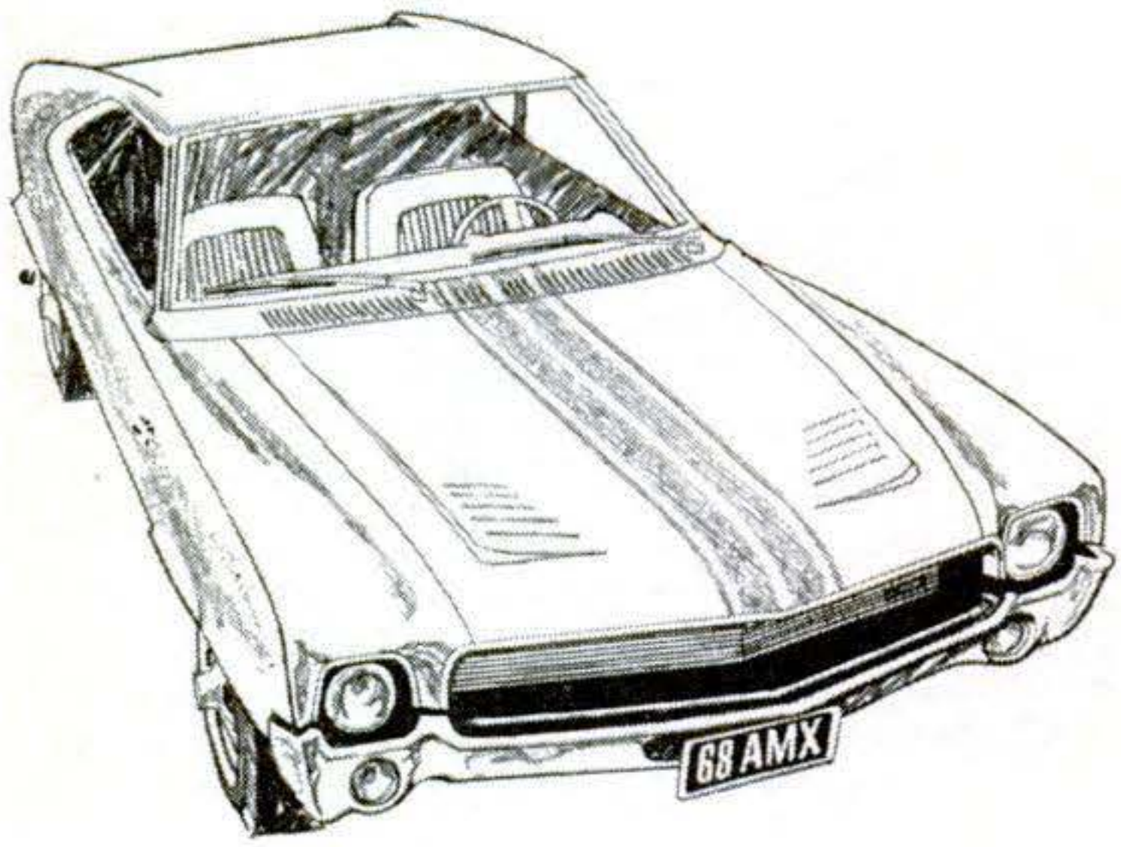

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Science Newsfront

[*Continued*]

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Men should let computers make decisions and stick to making the problems simple and understandable. Unlike computers, men are dimwits at data processing and shine more at reducing complex, changing information to numbers, says Prof. Ward Edwards of the University of Michigan. He proposes a man-machine decision system called PIP for Probabilistic Information Processing. As one example, it might be used for air-traffic control. Controllers would interpret the facts as they came in and let the computer issue the orders, instead of the reverse.

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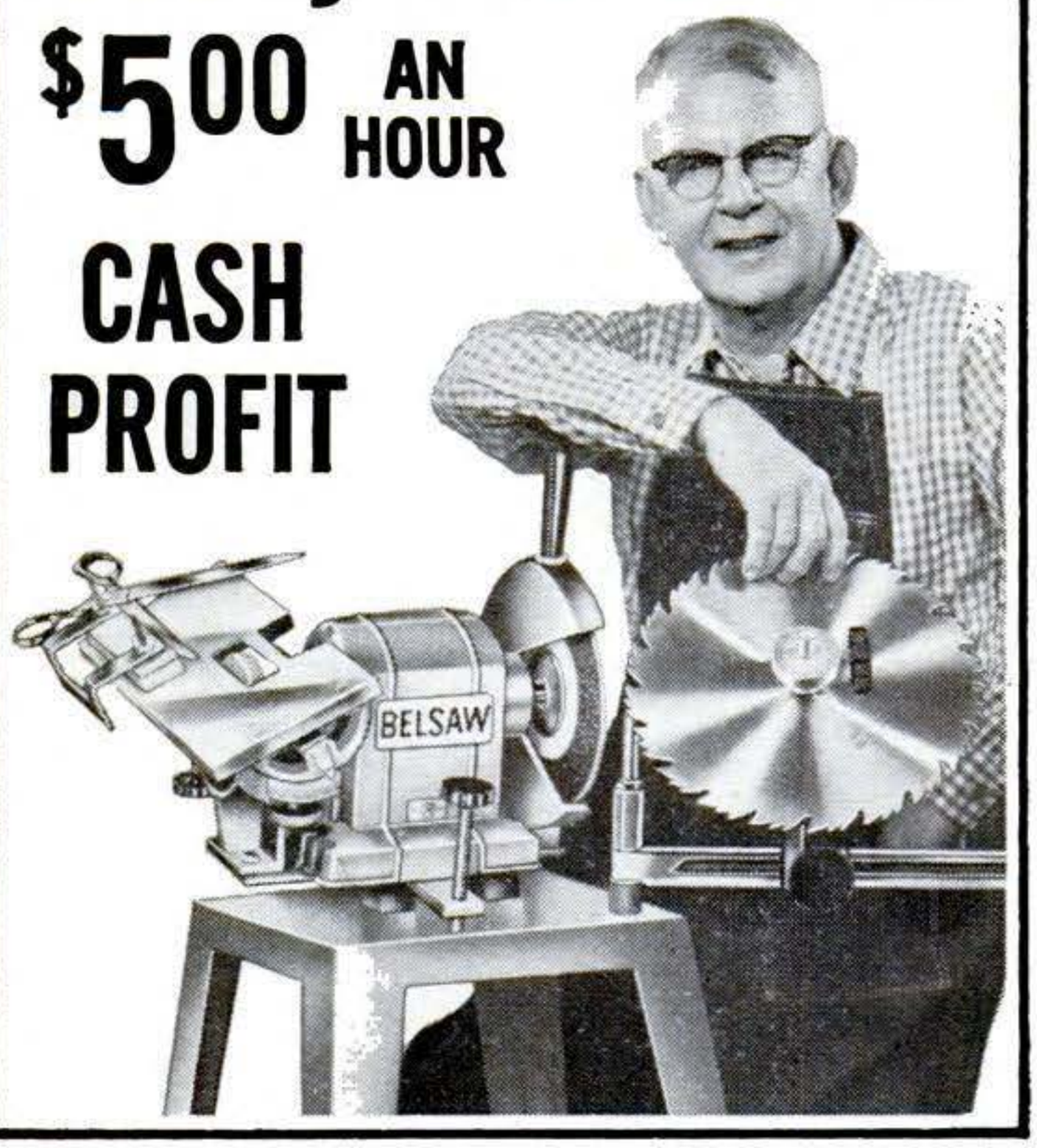

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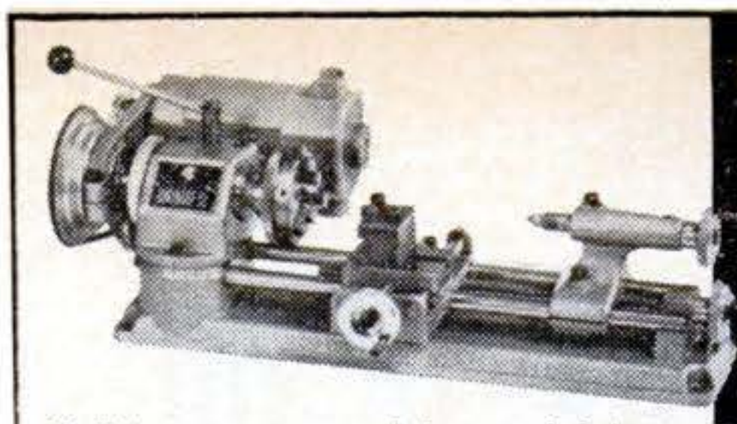

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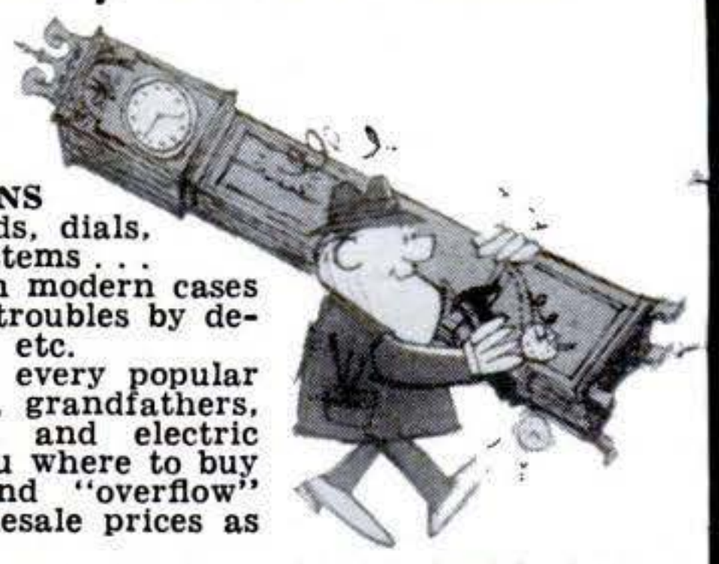

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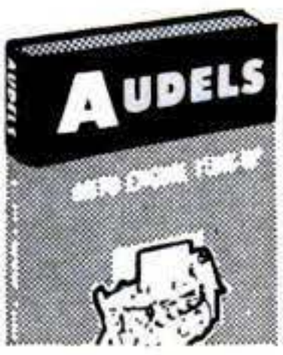

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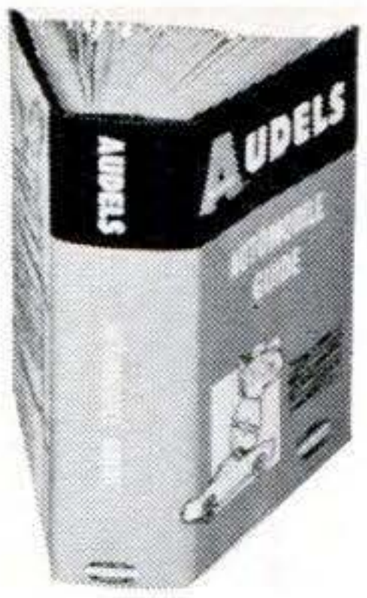

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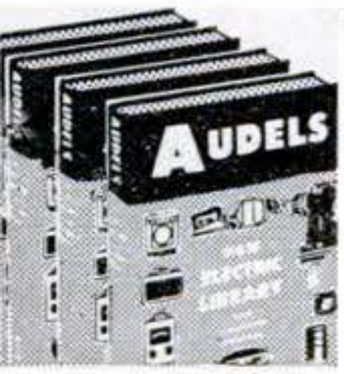

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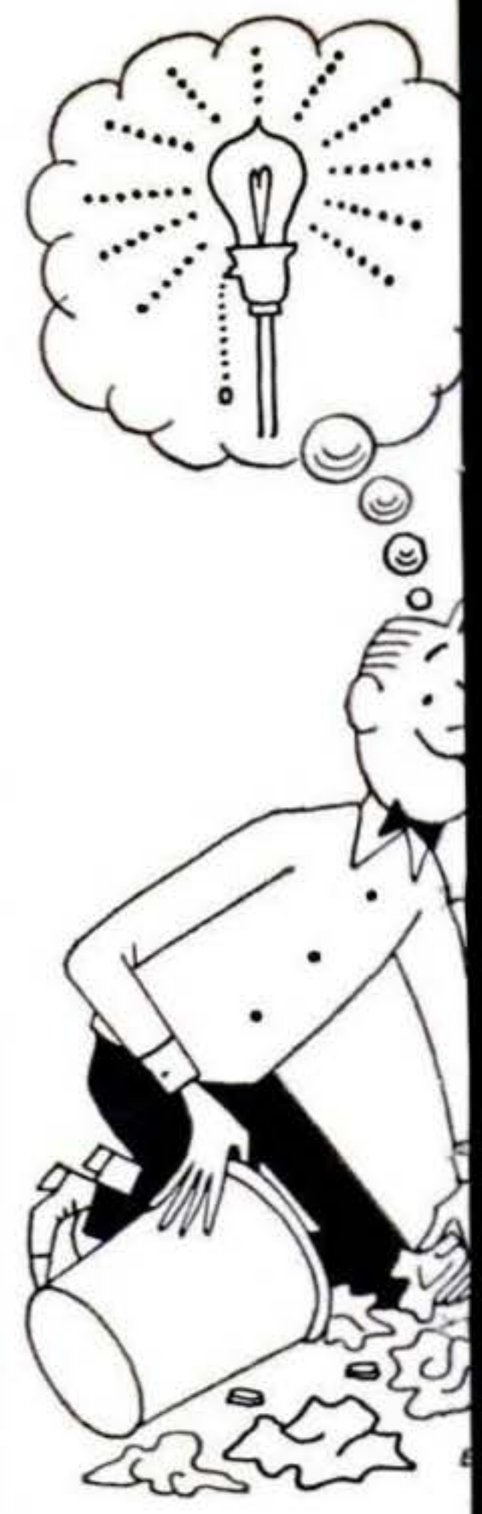

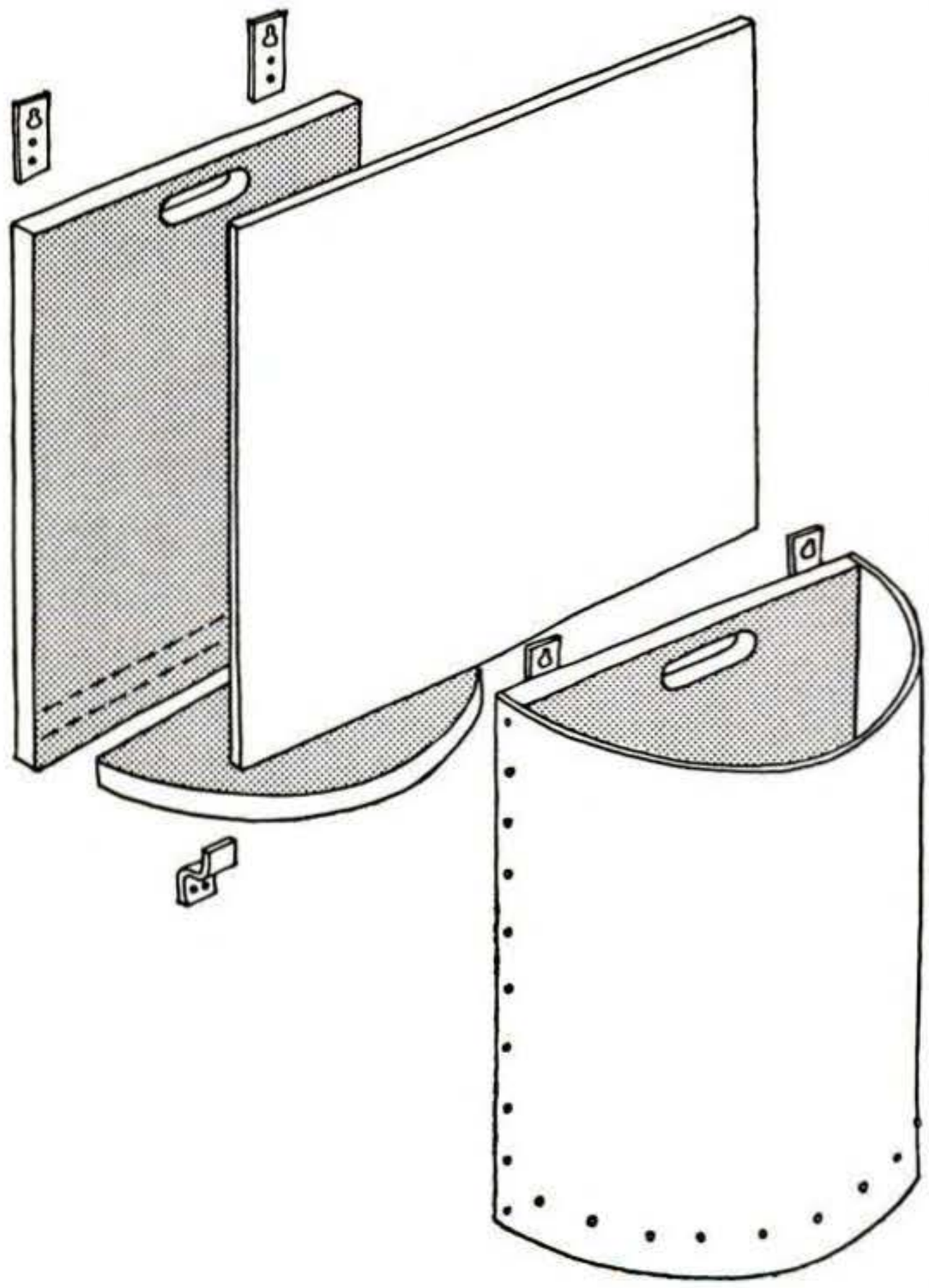

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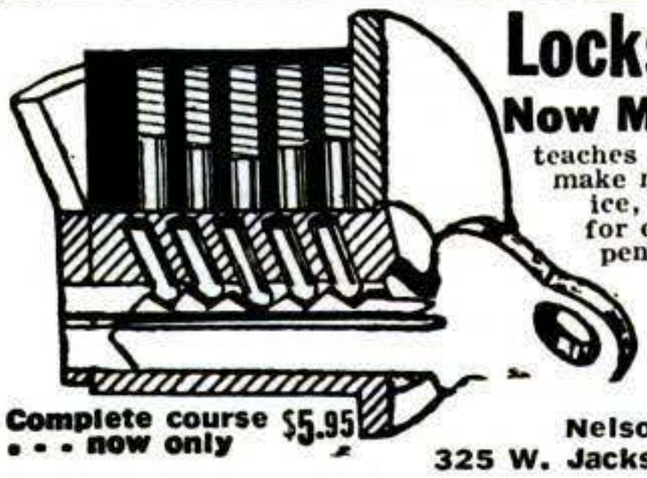

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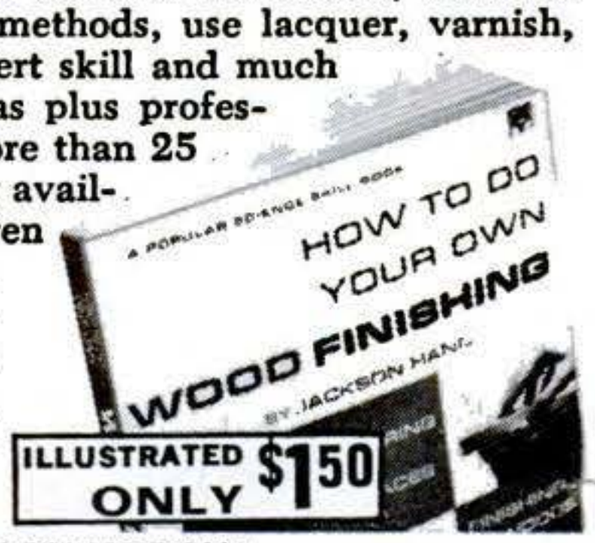

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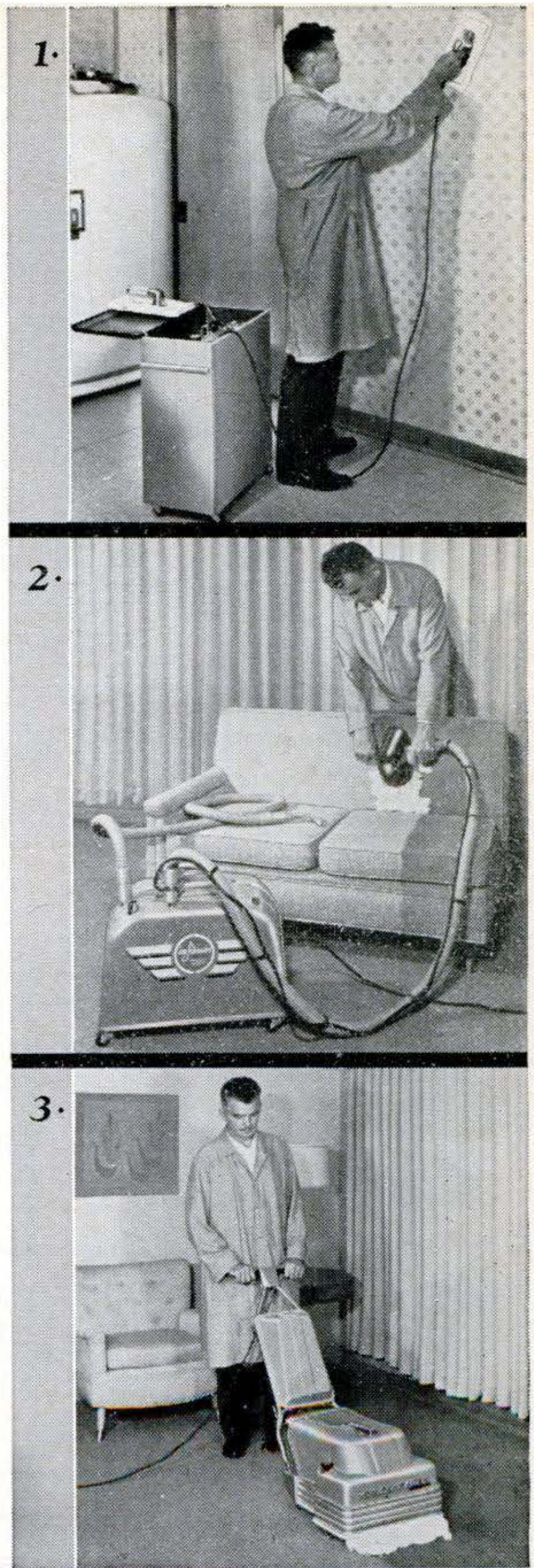

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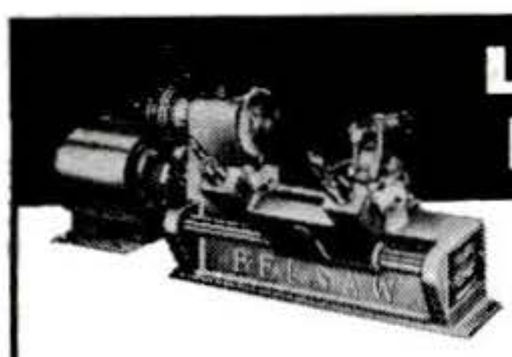

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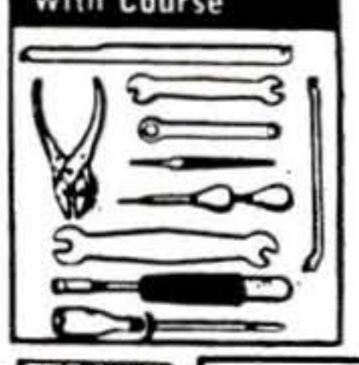

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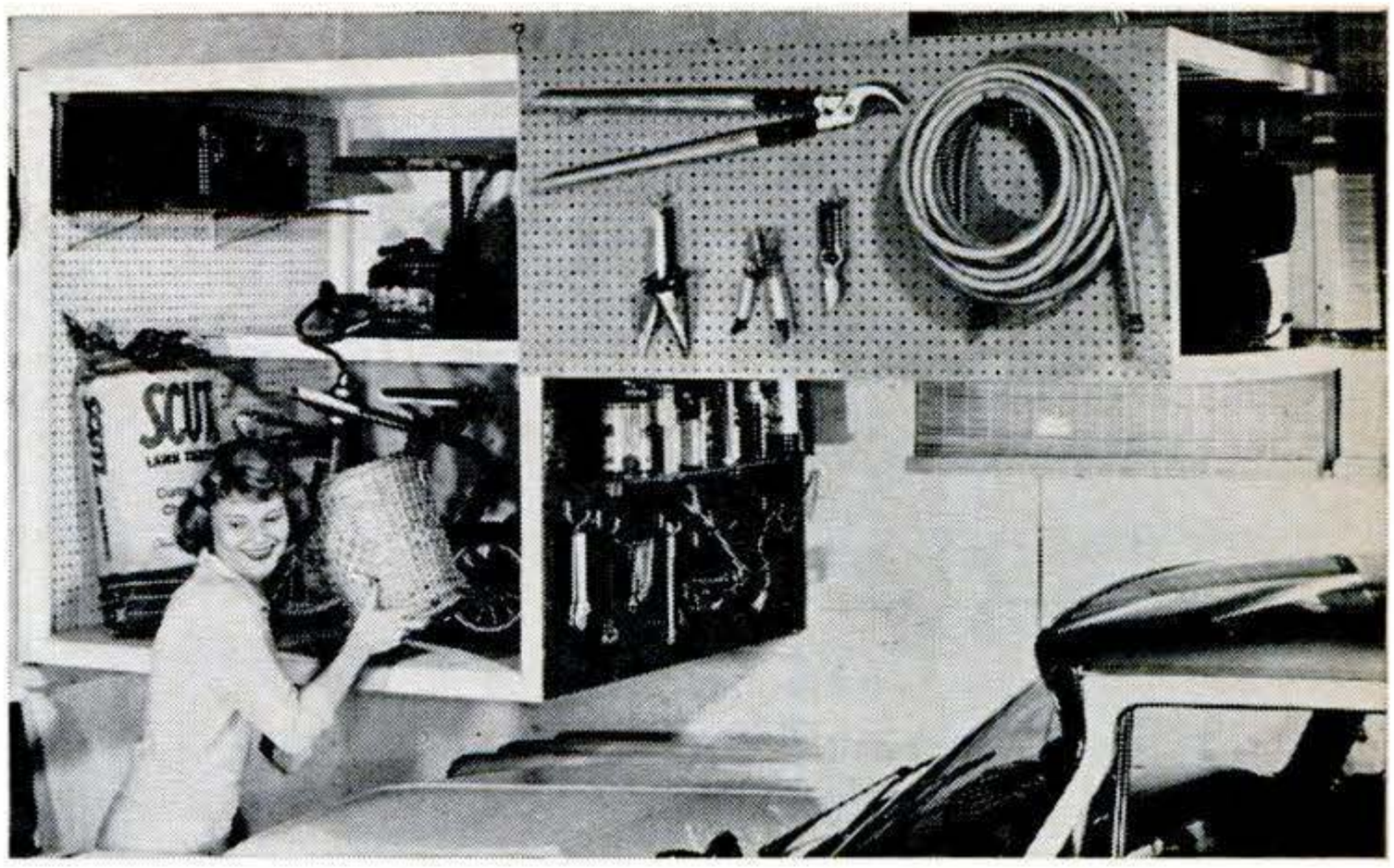

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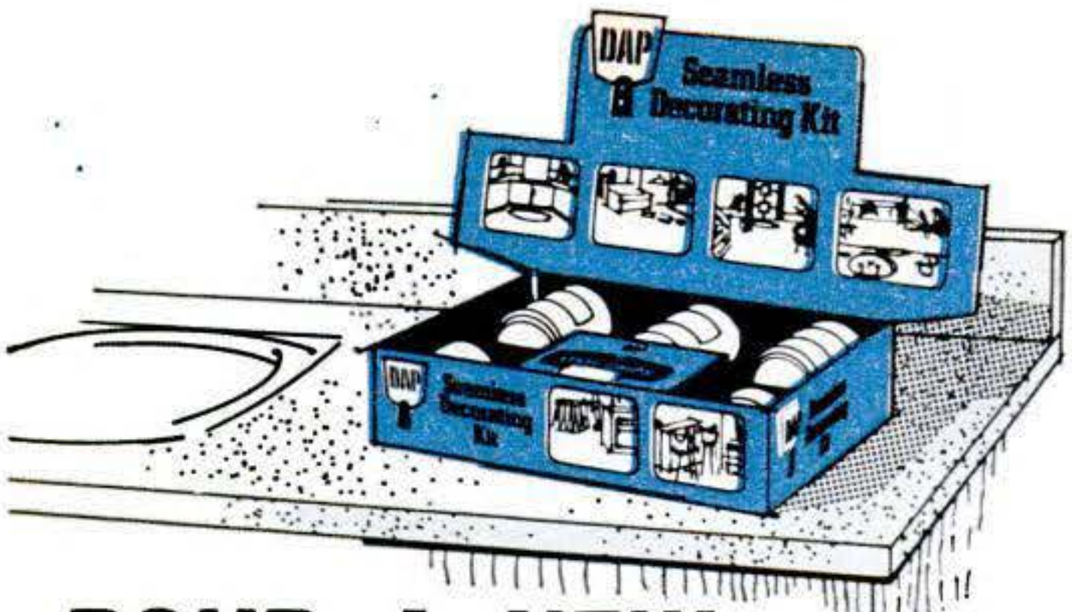

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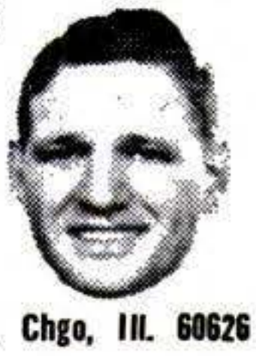

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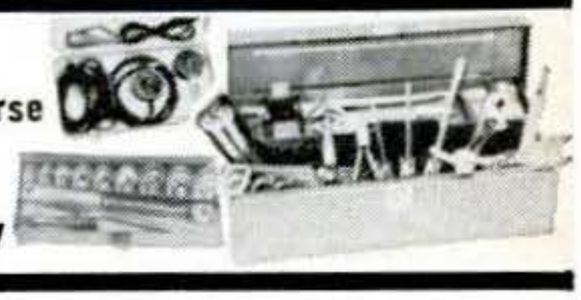

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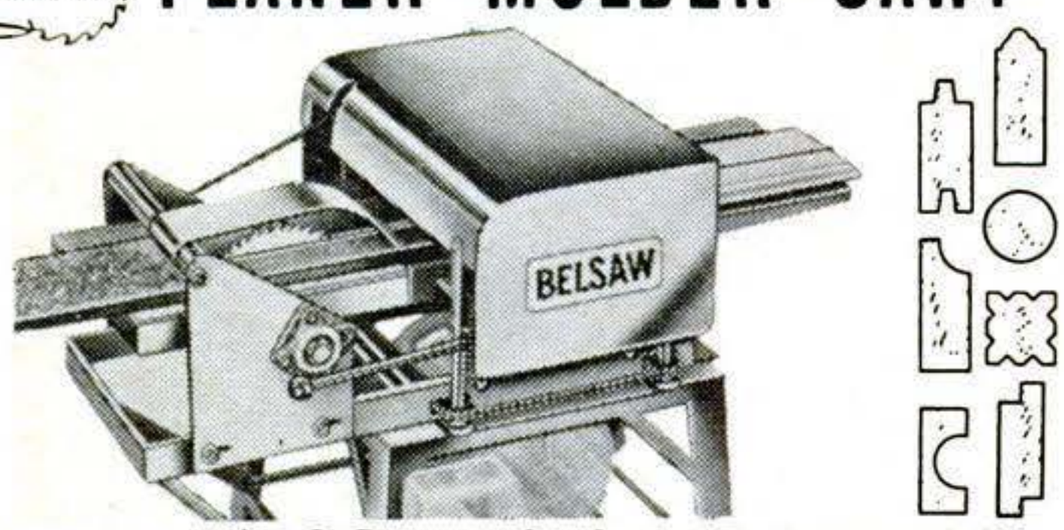

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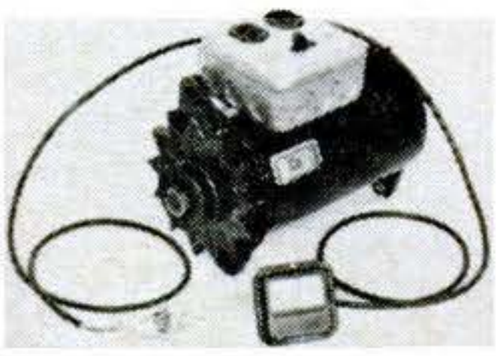

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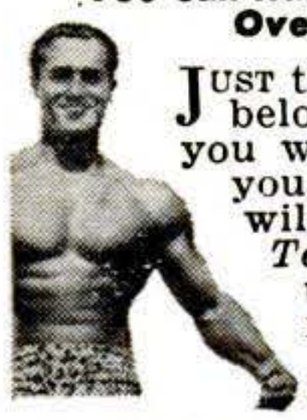

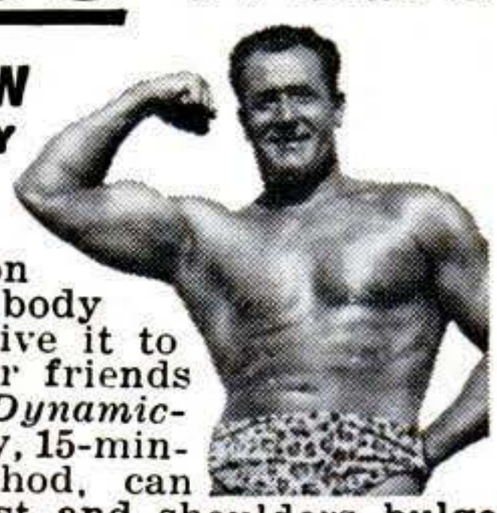

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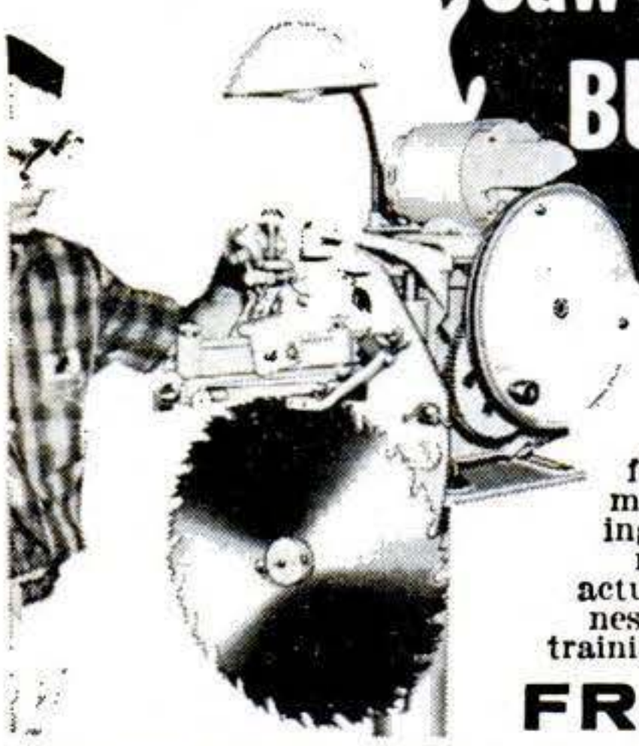

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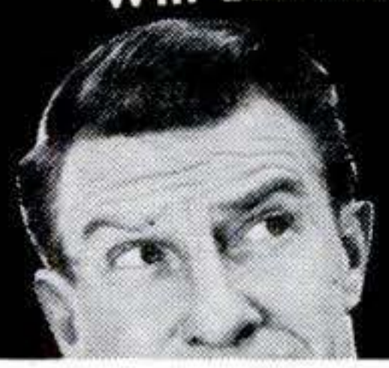

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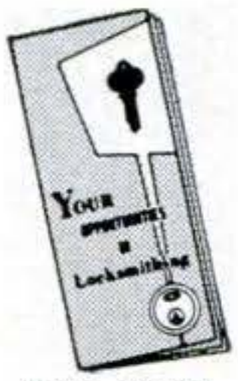

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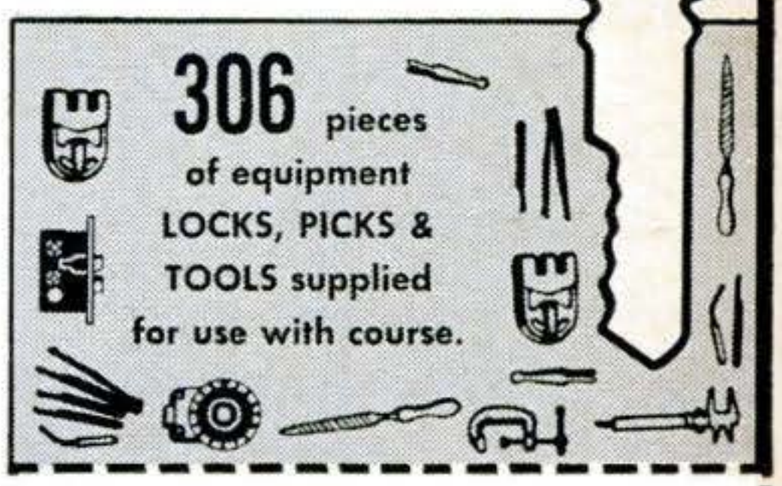

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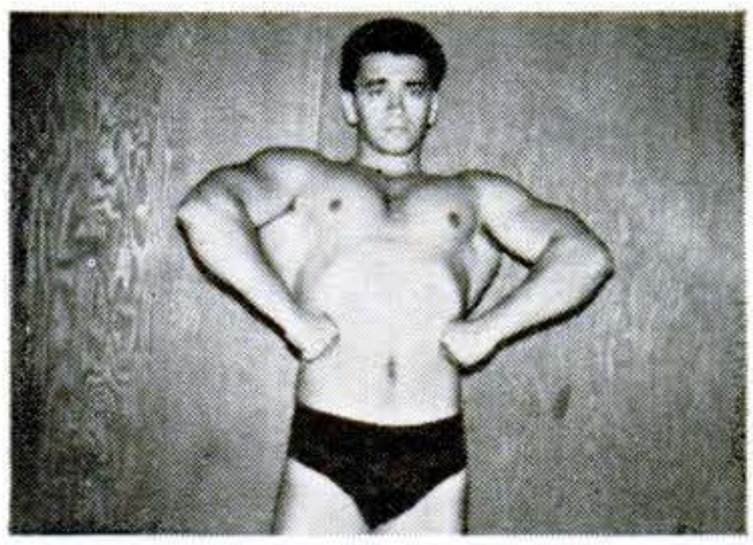

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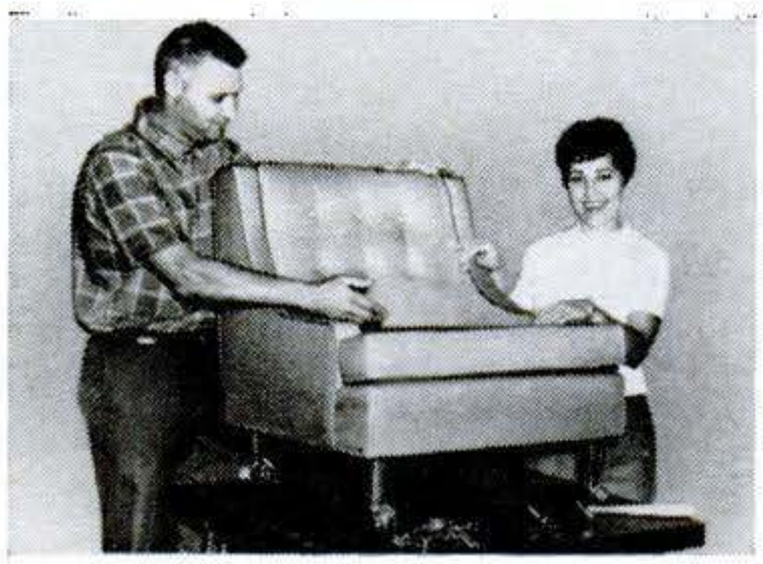

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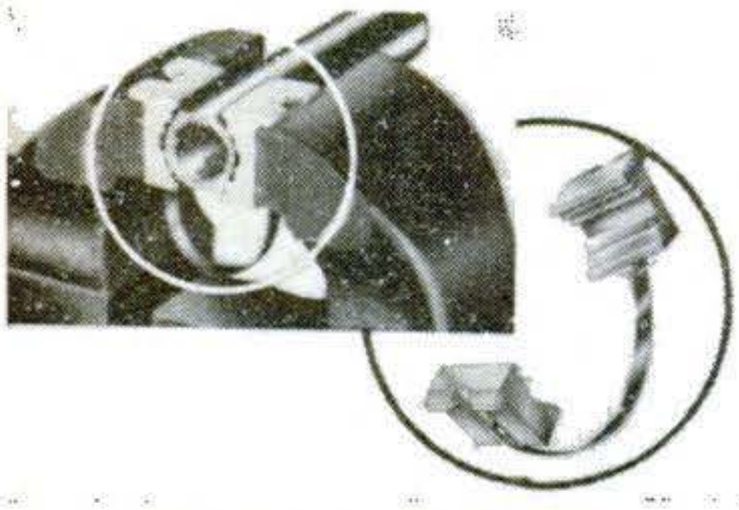

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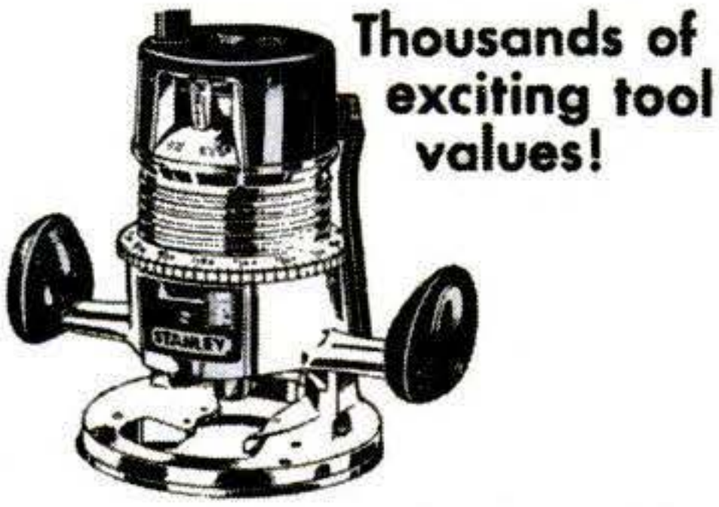

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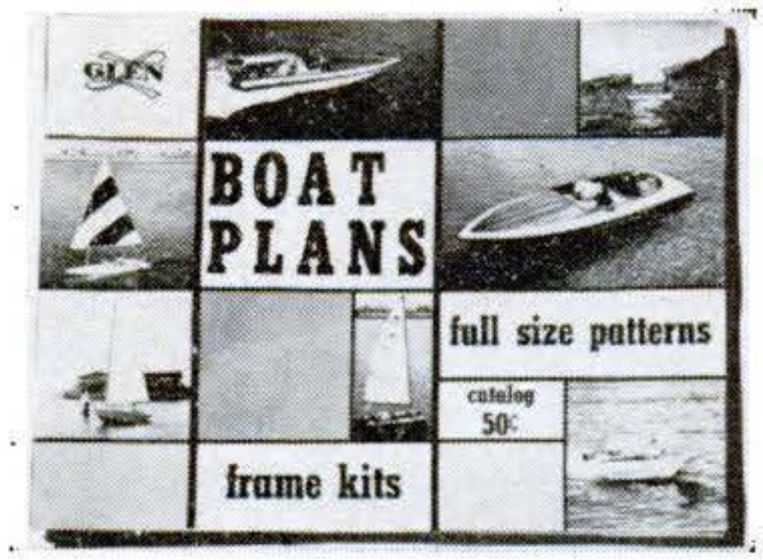

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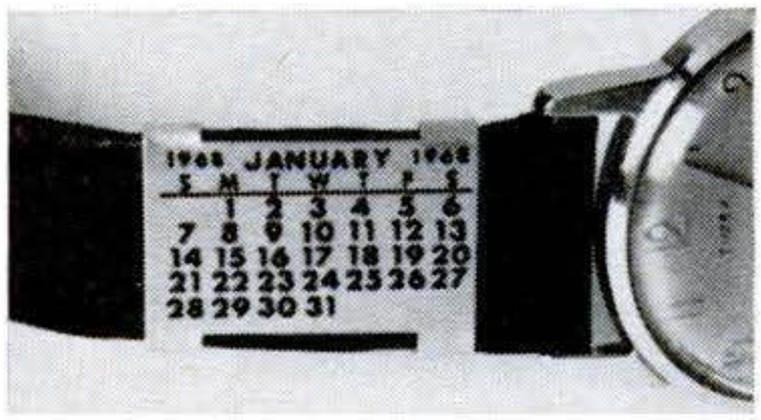

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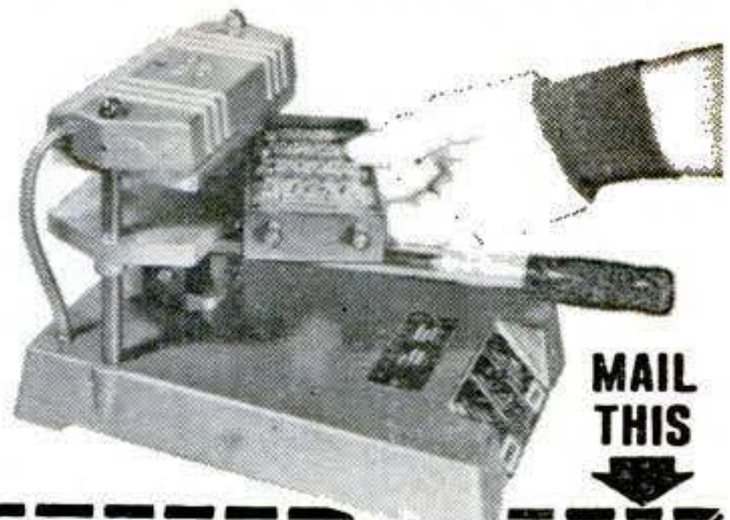

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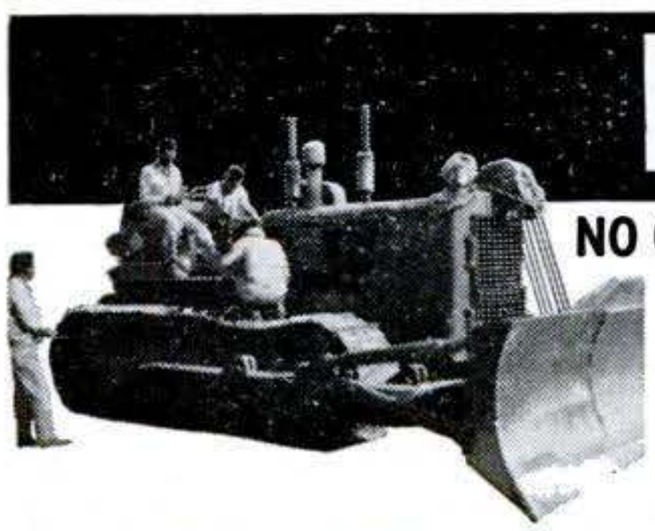

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Detroit Report...

DETROIT'S '69 MODELS WILL HAVE THE BIGGEST CHANGES SINCE '65. All full-size cars from GM, Ford, and Chrysler Corp. will be completely restyled--and that includes Cadillac, Buick, Olds, and Chrysler. In addition, Ford's Mustang and Cougar will get new skin, though overall appearance will change little. Controlled-crush front ends to soften the blow of a crash will be standard on Fords and Mercurys. Similar designs will show up on some GM cars, too.

Triple-locking will be a feature of new GM models. To steal a '69 Pontiac, for instance, you'd have to be a magician of Houdini caliber—if you didn't have a key. The new device will lock the steering wheel, transmission selector, and ignition, all with one turn of the key. The keyhole will be on the steering column halfway between the instrument panel and the steering wheel.

That inflatable bag for passenger protection that Pontiac was looking at two or three years ago is back in the news. Now a team of Ford and Eaton researchers have developed a new inflatable bag that will cushion the front-seat passenger in an accident. The bag fits in the roof rail above the windshield. A preset sensor in the front bumper signals a detonator circuit to open a high-pressure tube of gas.

The gas rushes through a diffuser into the bag and blows it up like a balloon. The inflated bag presses against the body of the passenger, keeping him from striking panel or windshield. Immediately after full inflation, the bag deflates to avoid rebound. The driver has a different bag, mounted on the steering column, low enough to allow full vision and steering. With the bag, occupants can survive a head-on 30-m.p.h. crash.

Two more electric cars are due from General Motors within the next two months. This will renew the public clamor for a production model—but it seems that right now an electric car would not be a big item in the marketplace. Even the most optimistic boosters of electric power feel that electric cars will be restricted to use as second or third cars in multicar families, and that such cars are still five to 10 years away.

A switch to aerodynamic designs will be the biggest change at Indy this year, apart from the new turbine cars. Clint Brawner is building a new streamlined car for Mario Andretti, following wind-tunnel tests at Dearborn that proved that the '67 championship car was all wrong aerodynamically. All suspension and steering parts will now have smoother shapes.

Ford brake engineers, preparing their cars for the Union/Pure Oil Trials, confirmed the findings of our Norbye/Dunne reports. Ford brakes, after repeated stops, are unable to lock the wheels in a panic stop. Our own tests show that pedal pressure skyrocketed beyond acceptable limits after 7-10 stops from 60 m.p.h. The cars stopped, but the brakes had lost the power to lock the wheels. Ford engineers blame the deficiency on the new single-caliper disk brake and will try different friction materials.

Chevy's answer to rising imported-car sales may be—paradoxically—another import. If Chevy actually brings out a subcompact (smaller than the Corvair), chances are it will be built in Canada. Present trade agreements encourage car imports from Canada, and there is a steady flow of Canadian-built, U.S.-designed cars into the States.

European and Japanese cars are taking almost 10 percent of the American market. Recent surveys show U.S. buyers prefer them for four main reasons, all spelled M-O-N-E-Y. Foreign economy cars have low first cost, high resale value, low operating costs, low repair and maintenance costs. One secret reason that does not show up in surveys is that imported-car buyers have a desire to be different—own a car out of the ordinary. This is the kind of motivation that Detroit cannot fight—and one that Detroit feels is the strongest influence on the market.

Jim Dunne

Detroit Editor

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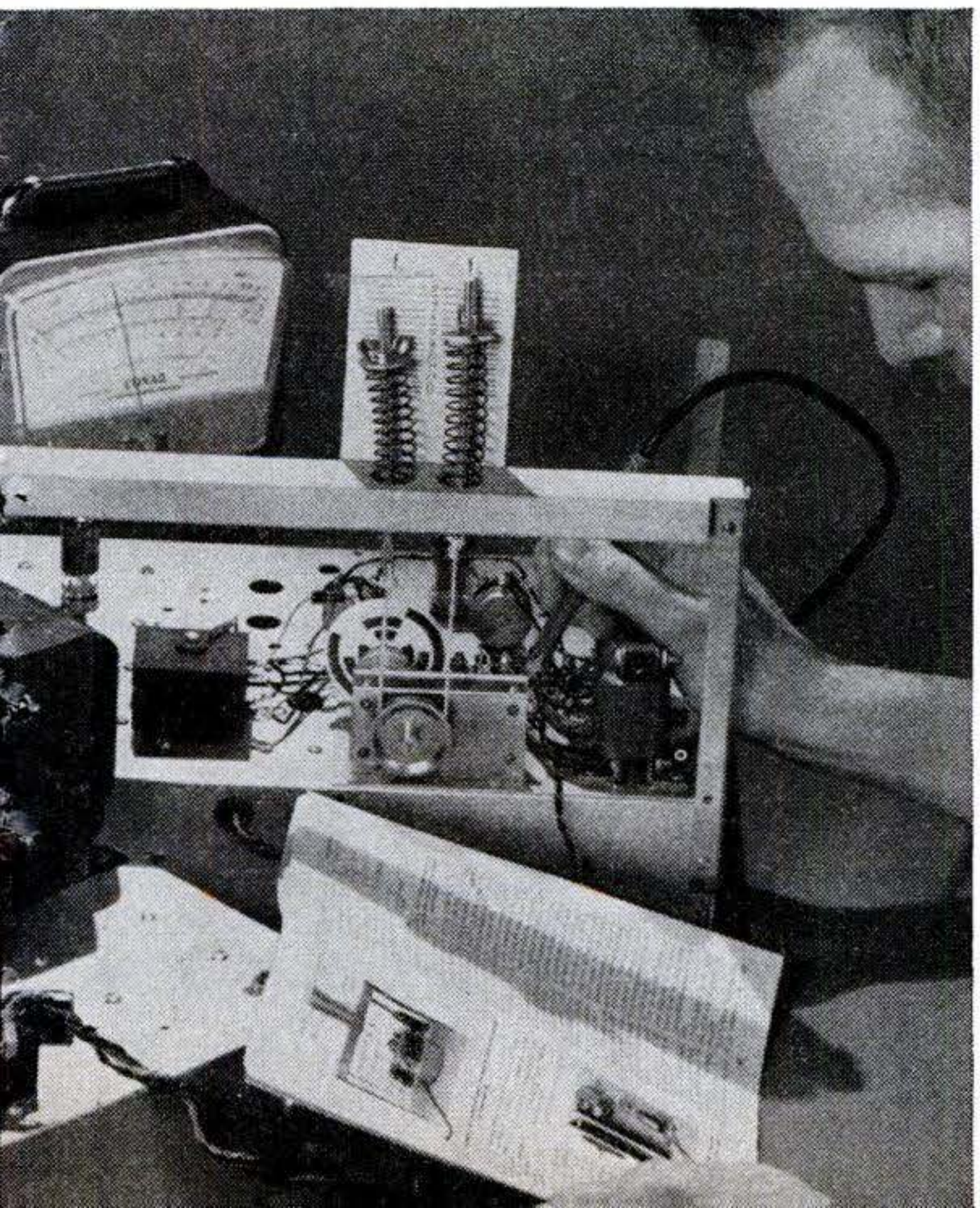

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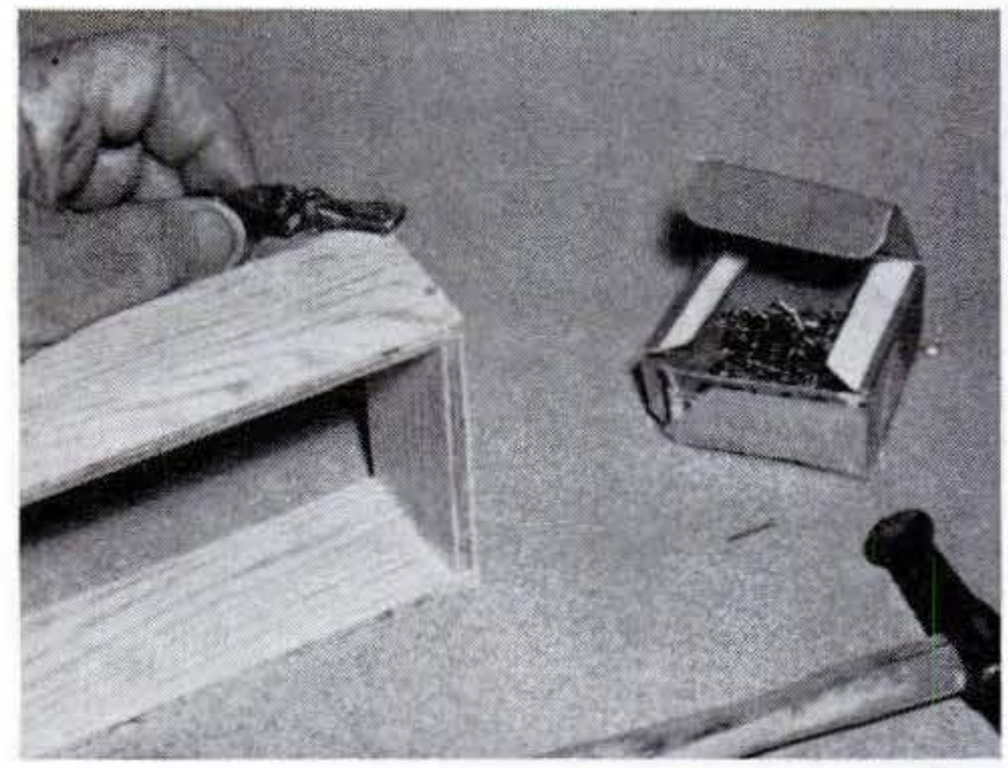


Clamp holds brads—saves fingers

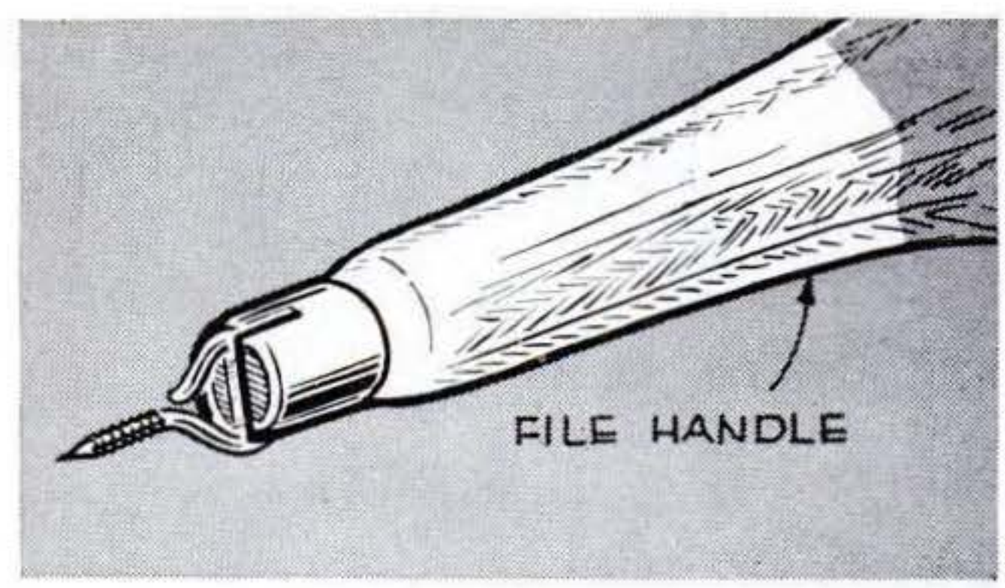
An electrical test clamp is just right for gripping small nails, brads, or tacks when the job calls for them. A medium-size clip —with a strong spring and alligator jaws— is available at most hardware and electrical-supply stores at nominal cost.

W. G. WAGGONER, Sacramento, Calif.

Paintbrush patches small cracks

There's an easy way to patch corner cracks that are too large to leave—but so small that they're not worth the putty-knife and sanding routine. A wet ½-inch paintbrush will carry enough plaster to fill and smooth in one step. The same brush dipped in water does a professional job of "sanding" knife-patched corners.

BOB KIRK, Manhattan, Kans.



Screw-hook driver for tight spots

Next time you have to drive screw hooks in hard-to-reach places improvise a holder from a file handle. Plug the tang hole with a dowel; then slot dowel (and the handle's ferrule) to take the hook. A wide slot in the tool will handle most sizes.

PETER LEGON, Malden, Mass.

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Saturday's hero

Like most guys, you probably prefer weekend golf to weekend yardwork.

But you'd still like to have a good-looking yard—if you didn't have to shoot your Saturdays on it.

A Hudson power sprayer can help save the day. Just hitch it to your tractor. Whip through your yard spraying jobs. And have more time left for the things you want to do.

No other tractor attachment can do as many different jobs. Here are some of the ways you can use a Hudson power sprayer nearly year 'round:

Get rid of weeds, disease and insects in your lawn. Apply fertilizer.

Stop insects and disease on flowers, ornamentals, trees. Banish mosquitoes and other annoying insects. Fertilize shrubs and trees at roots or through leaves. And deep-water them.

Power-wash buildings, patios. Apply white-wash, shingle stain. Disinfect refuse containers, kennels. Seal concrete to prevent salt damage. Spray-coat ornamentals to prevent freeze damage. Stop home-invading insects around foundations.

For those reasons, a Hudson power sprayer makes your tractor investment look better than ever.

Choose from our 12½-gallon Suburban* Trail-N-Spray* or our 15, 30 or 50-gallon Matador®.

Get details from lawn and garden or implement dealers throughout the United States and Canada. Or write: H. D. Hudson Manufacturing Company, 589 E. Illinois Street, Chicago, Illinois 60611. *Trademark

HUDSON®
POWER SPRAYERS

SIGN OF THE BEST BUY
HUDSON®

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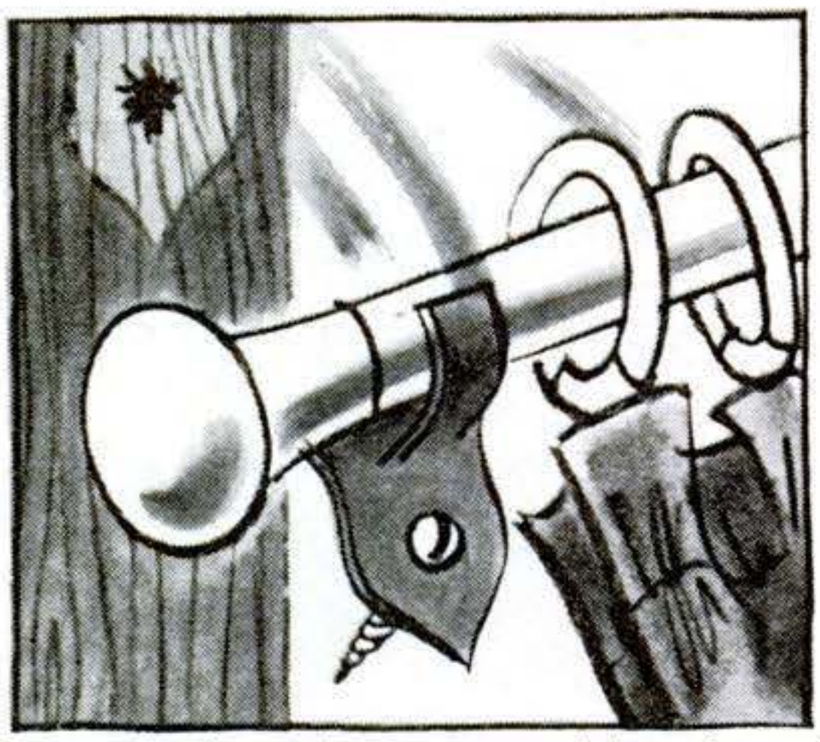
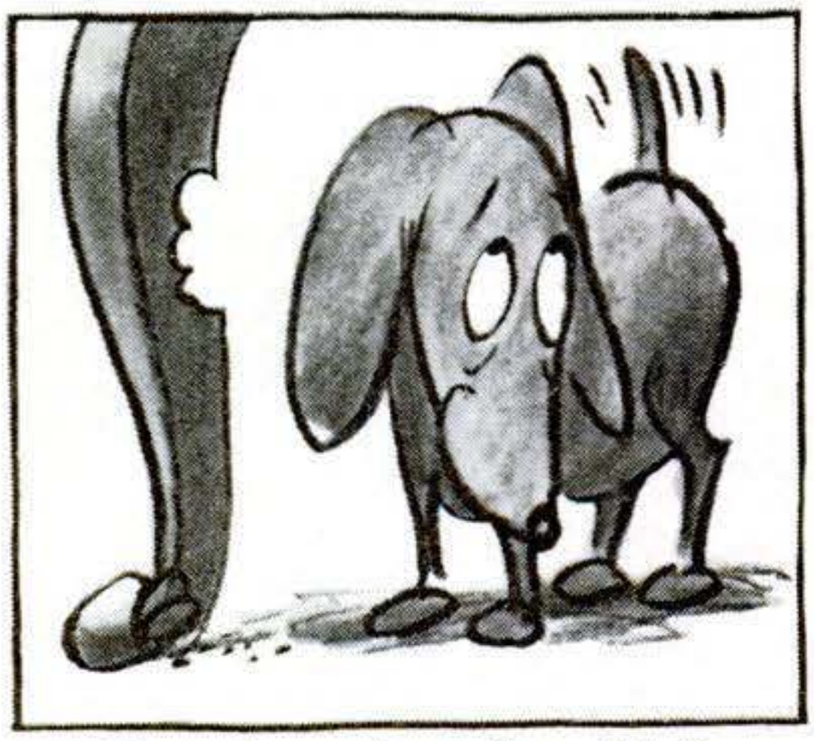
?@!★⚡*7†★#*⚠†%

Your five-year-old banged a hole in the floor?

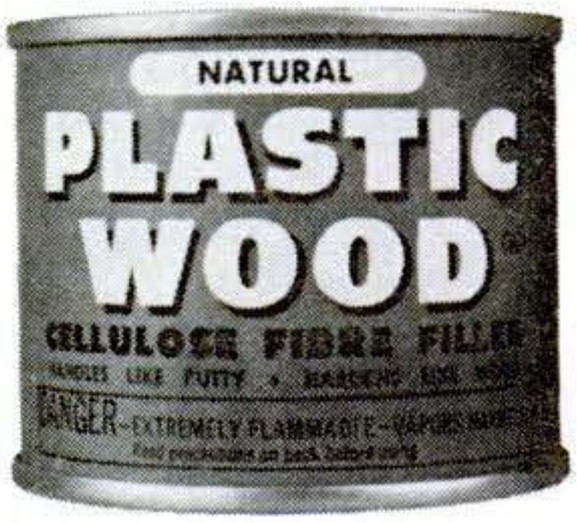


The curtain rod came crashing down?

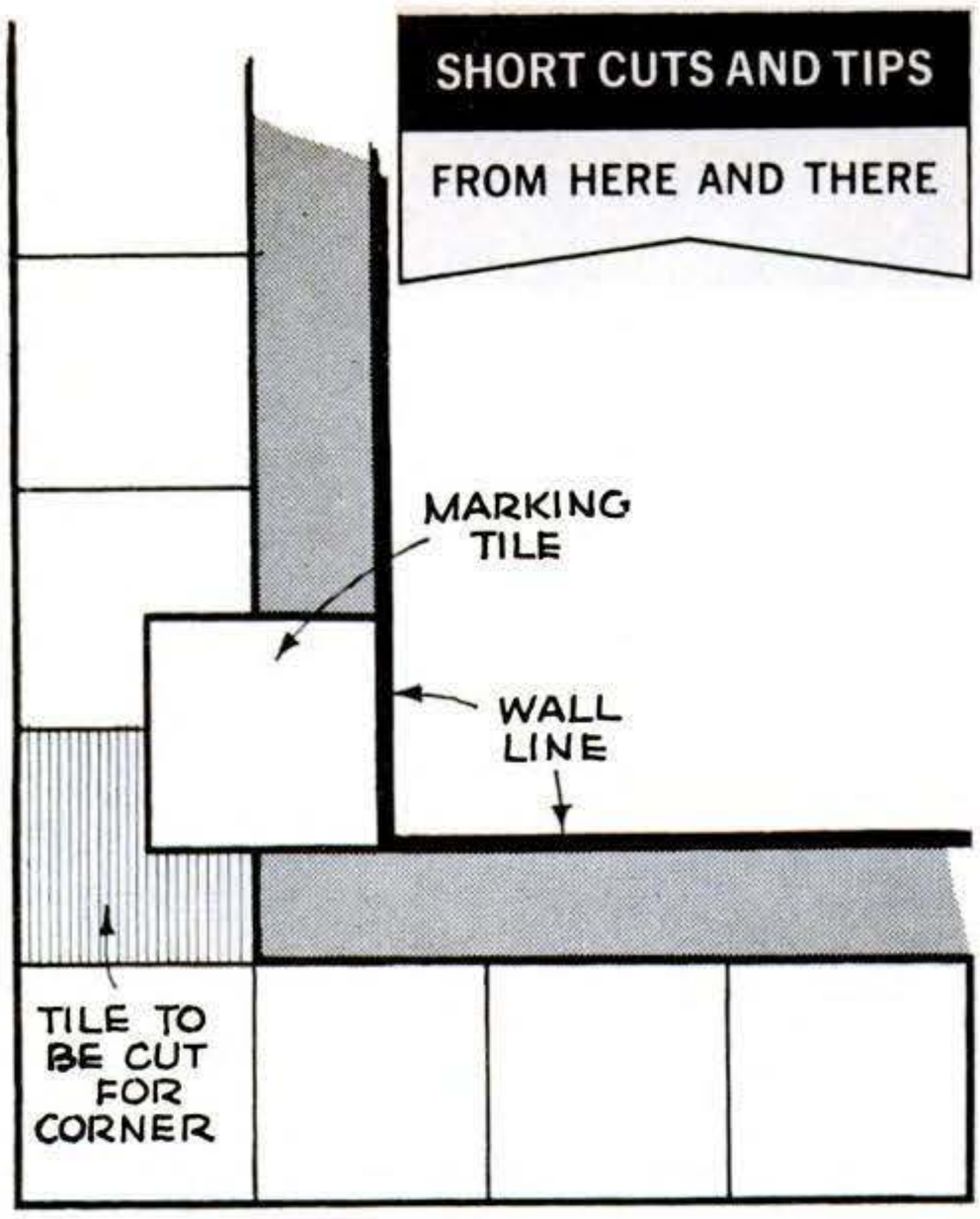


Pup chewed on the table?

Fix it with the
genuine PLASTIC WOOD.®
Looks and lasts like real wood.



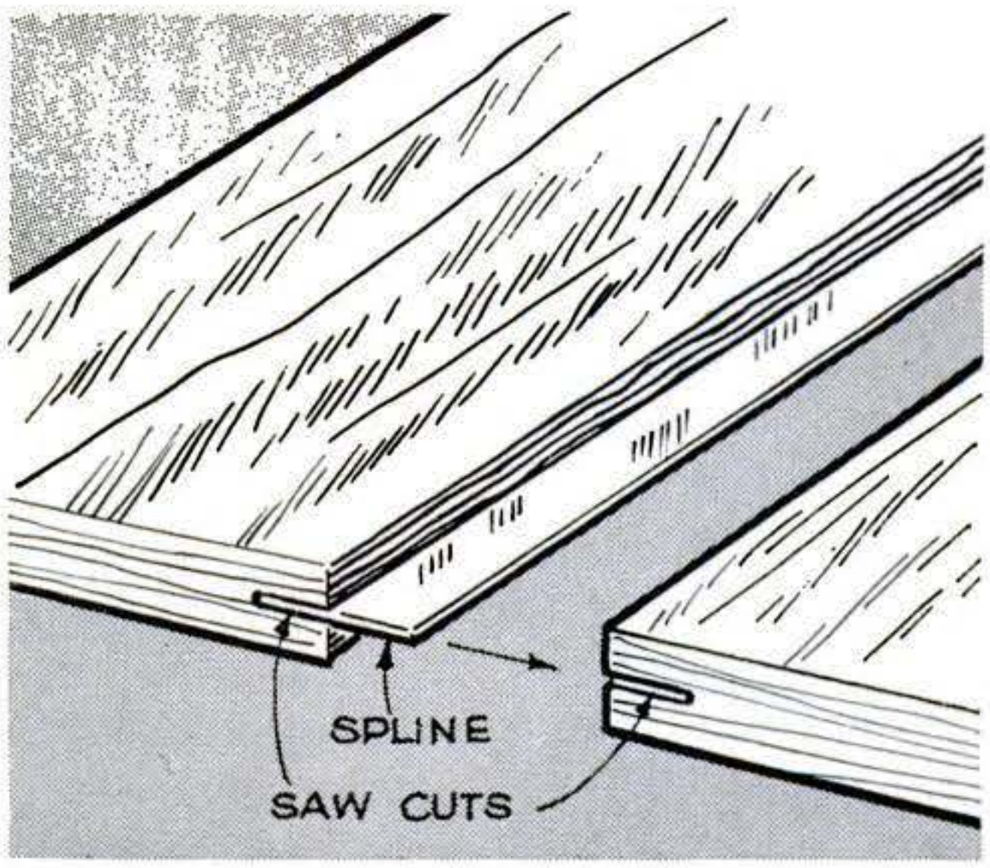
Handles like putty—comes in 5 colors.



Mark corner tiles in one step

Most people know the trick for cutting border tiles: placing a tile directly over a laid one and marking with a third. Here's a fast way to cut a tile that must be fitted around a corner. Place the marking tile so that it lines up with the corner—not the tile to be cut—and mark both sides at once. Use trick on square corners only.

B. W. VORE, Parkersburg, W. Va.



Edge spline made of laminate

A strip of plastic laminate (7/8" wide) is excellent spline material when edge-gluing boards. Rip a saw cut 1/2" deep along the center of the boards to be joined (a fine-tooth plywood blade gives you just about the right kerf). Apply glue to the plastic and to the edges of the board, and then clamp them together.

LEO R. NIEMI, Warren, Ohio.

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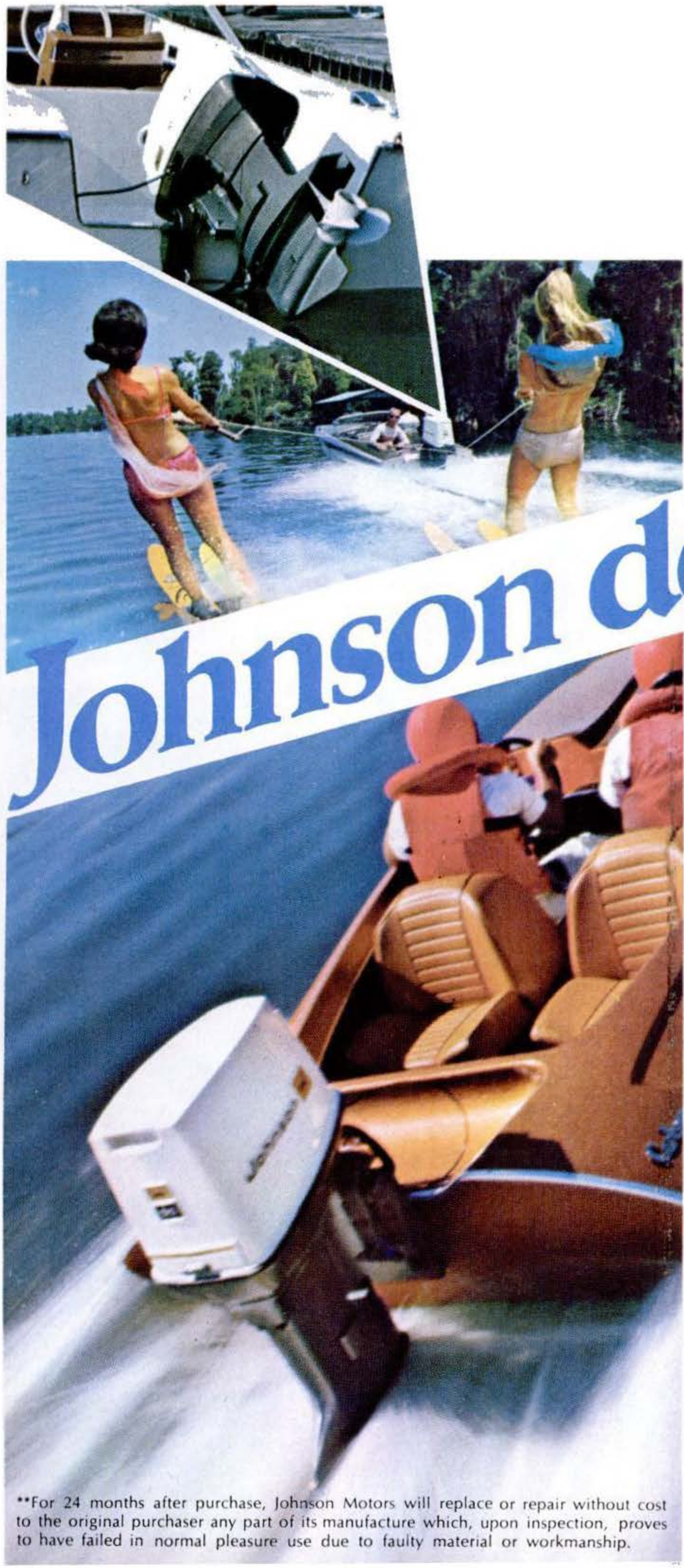

A completely NEW* idea in the mid-power range for 1968

Johnson delivers ...dependably!

Sea-Horse 55 is America's first multi-cylinder outboard with loop-charging. The most potent motor in the mid-horsepower range.

- **Powerhead** — 3 domed cylinders ported to loop the fuel charge for more efficient combustion, more power per cubic inch. Instant starts, all-speed smoothness with Power/Pulse ignition. New fool-proof thermo-electric choke.
- **Mid-section** — Tuned exhaust makes the most of available fuel energy. Patented Water-Shield silencing drowns exhaust noises.
- **Business end** — Gearcase shape, prop diameter and gear ratios all computer selected, hydrodynamically tested for most effective thrust at every throttle setting. Fail-safe power-shifting with revolutionary Hydro-Electric drive.

Famous two-year warranty**. See your Johnson Dealer — or write for free catalog. Johnson Motors, Waukegan, Ill. 60085, Dept. PS-83

*Not merely warmed over.

**For 24 months after purchase, Johnson Motors will replace or repair without cost to the original purchaser any part of its manufacture which, upon inspection, proves to have failed in normal pleasure use due to faulty material or workmanship.

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Division Outboard Marine Corporation

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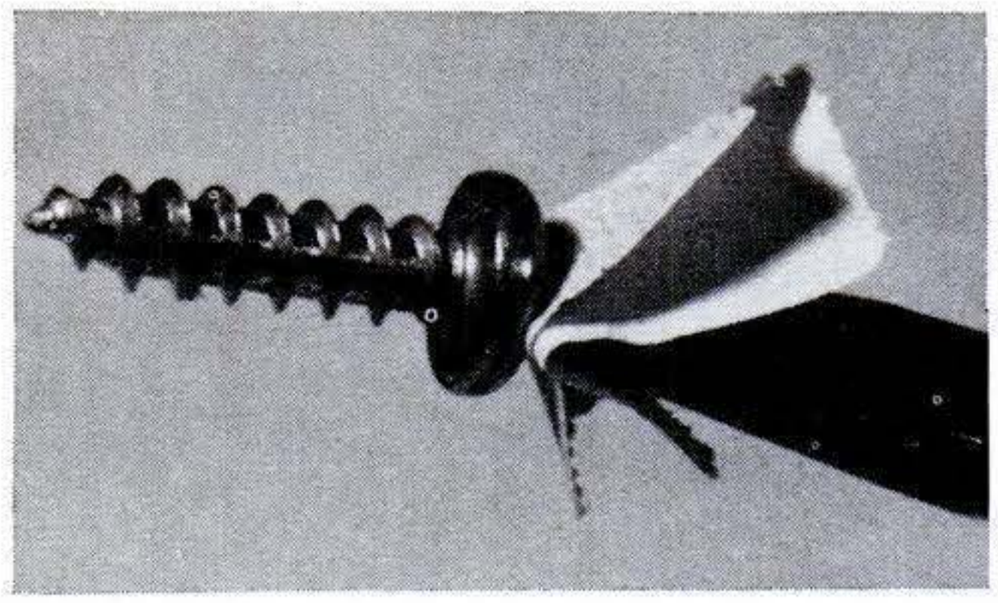
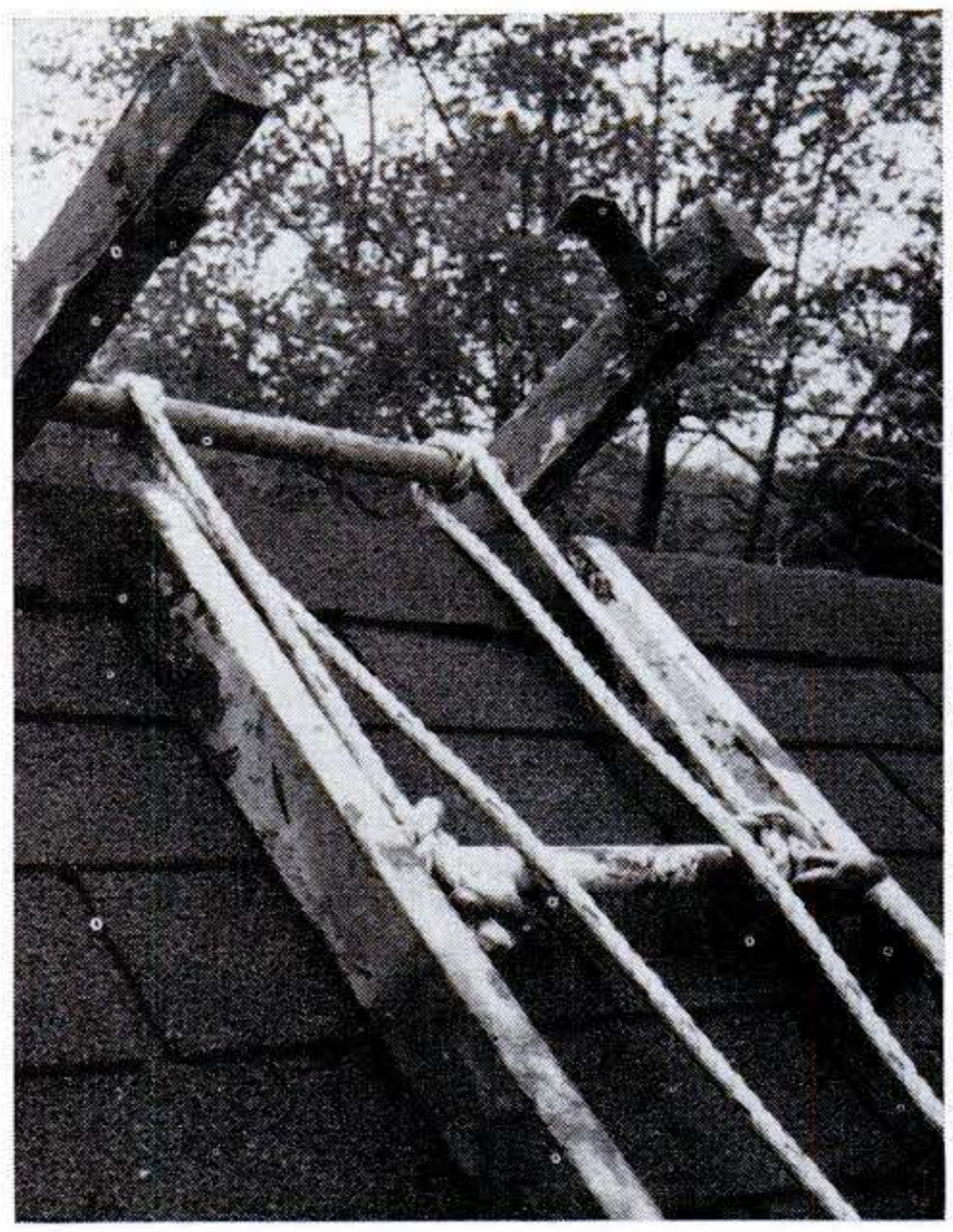


Sticky trick for driving screws

A small piece of masking (or transparent) tape—folded sticky side out lets you drive screws in unreachable places where you can't get your fingers. Put the tape on the screwdriver first, then press the screw on the taped blade.

EARLE JACKSON, Tucson, Ariz.



Safe way to walk up a steep roof

If your roof has a steep pitch try this trick. Hang one half of your ladder down each side of the ridge and secure them with a doubled length of rope. Clove-hitch the rope ends to the top rung of the work-ladder half and take two turns around the top rung of the other. Lower the work half by slackening the line.

JACKSON HAND, Westport, Conn.

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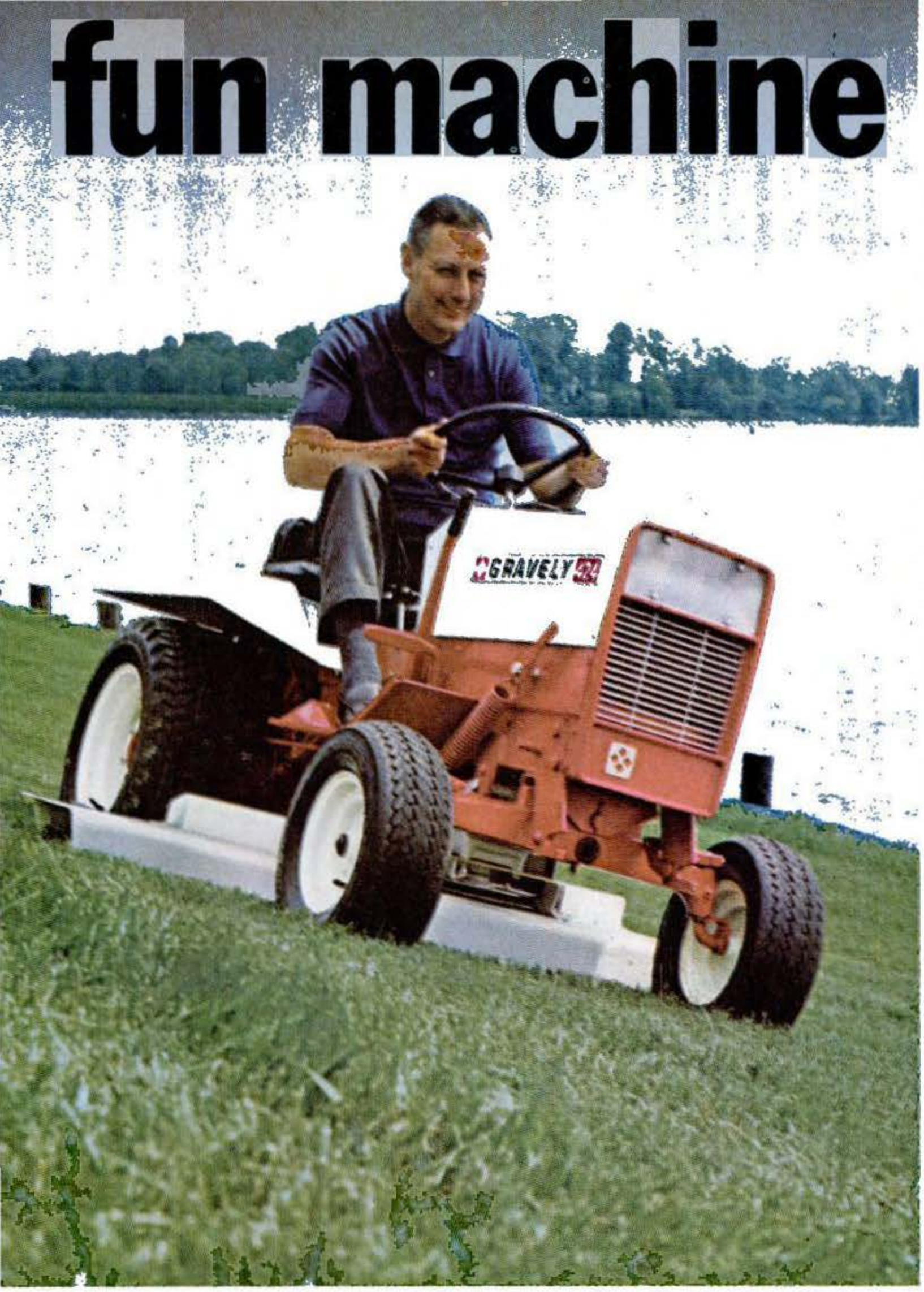
fun machine



Come see the great new GRAVELY-424

Love that power! You'll get real satisfaction when you take command of the finest compact tractor that ever mowed a lawn or plowed a furrow! It's Gravely . . . so you know it's a real working machine. Uphill. Sidehill. Over the rough spots. 10 HP engine in the rear gives you full power, ground-hugging traction that lets you have the fun while the tractor does the work.

Love that all-gear drive! The Gravely 424 drive is all-gear-and-steel shaft . . . puts the power where the action is, into the attachments doing the job. There are no belts to slip or break . . . it's gear and steel all the way.

Love those attachments! Easy on. Easy off. Attachments mount quickly down under, up front, or behind. You're in command of any job . . . mowing, snow clearing, gardening and dozens more!

Fun to use, easy to buy! See the Gravely 424 at your Gravely dealer. Talk terms. He'll talk your language. Or, write for a free, full-color catalog: Gravely, 5803 Gravely Lane, Dunbar, West Virginia 25064.

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The compact tractor you'll love at first sight!

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NEW DREMEL ELECTRIC ENGRAVER

with solid carbide engraving point

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This new compact Dremel permanently engraves names or identification numbers on steel, copper, brass, silver, aluminum, glass, wood, plastic. Handy for marking tools, personal and business valuables, jewelry, industrial tools and dies — anything requiring permanent identification. Weighs only 7 ozs. Exclusive **calibrated** stroke adjustment regulates depth of engraving. Solid carbide engraving point. Diamond points also available.

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Model 290 with molded storage case . . . $14.95

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✓ COMPACT or LIMOUSINE ✓ 4, 6 or 8 CYLINDER
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DWELL TACHOMETER

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MADE ORIGINALLY FOR THE PROFESSIONAL AUTOMOTIVE TECHNICIAN, MODEL BT-162 WILL PAY FOR ITSELF MANY TIMES OVER FOR THE AUTOMOTIVE HOBBYIST AND EXPERIMENTER.

The Model BT-162 will perform the services specified below in addition to many other tasks too numerous to mention:

It is no longer necessary to file points to smoothness when using the Model BT-162. The instrument will automatically make allowance for any existing "pitting" or "wear." • Indicate the most effective point setting **without removing the distributor cap.** • Indicate the correct settings for **external adjustment type** distributors. • Car manufacturers' dwell angle recommendations are included in the manual provided with the Model BT-162. • To adjust for mathematically correct carburetor adjustment and thus insure maximum gas economy and quiet engine running, simply use the Tachometer section of the Model BT-162. • To locate a "miss" you need only disconnect or "short" the spark plugs one at a time with the Model BT-162 switched to the Tachometer position. You will be able to instantly identify which particular plug (or frequently its wire lead) is responsible for the malfunction. • Cars with automatic transmissions function efficiently only if the fluid pressures are correctly maintained. Detailed instructions show you how to use the 5000 RPM range for that purpose.

Comes complete, ready to use. Tune-up and operating procedure manual included, describes in detail how to make all tests. Also includes manufacturer's dwell angle recommendations for all cars. The manual is yours to keep even if you decide to return the instrument. **$29.95**

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Try it for 10 days before you buy. If completely satisfied then send $5.00 and pay the balance at the rate of $5.00 per month until the total price of $29.95 (plus P.P., handling and budget charge) is paid. If not completely satisfied, return to us, no explanation necessary.

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Please rush me one Model BT-162. If satisfactory I agree to pay $5.00 within 10 days and balance at rate of $5.00 per month until total price of $29.95 (plus P.P., handling and budget charge) is paid. If not satisfactory, I may return for cancellation of account.

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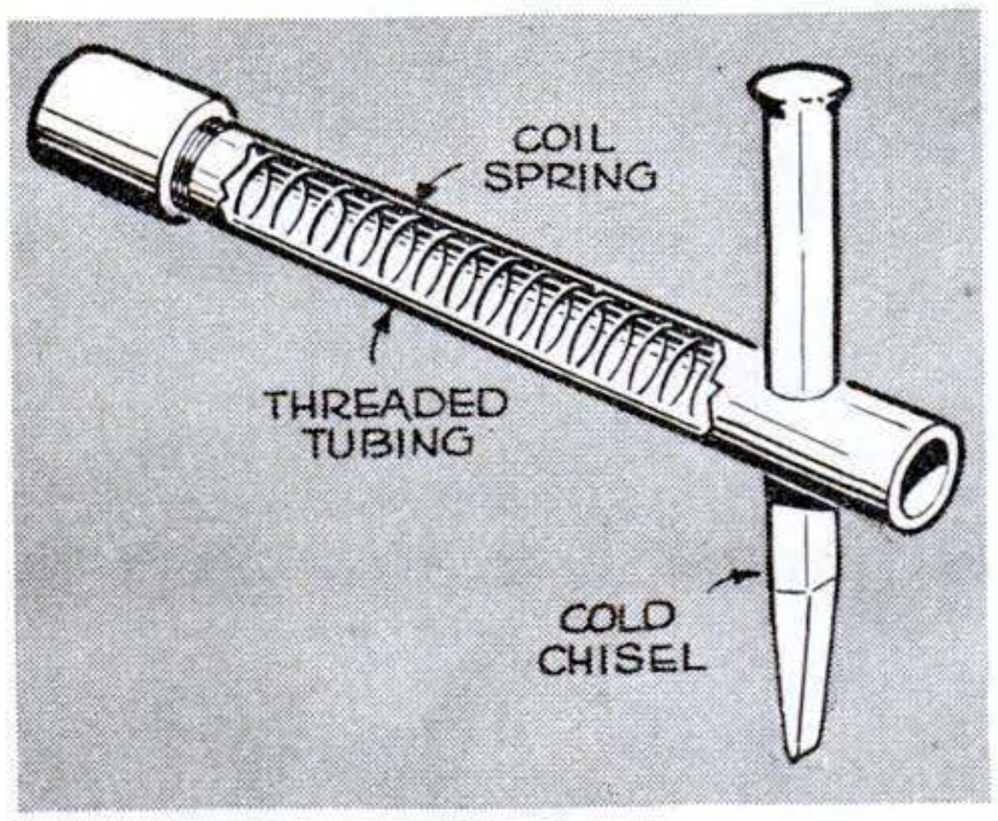
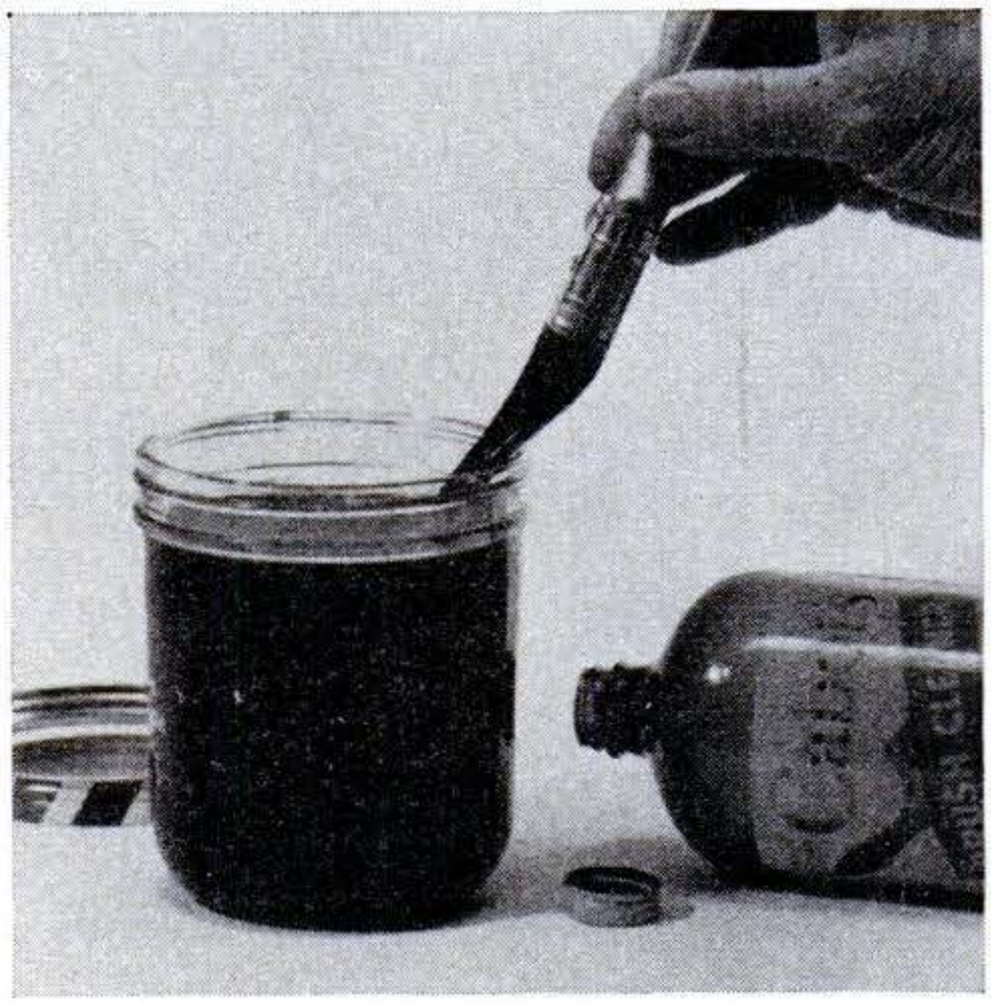


Holder takes rap if hammer misses

Your hands will be safe if you make this holder for your cold chisel. Drill a hole in one end of a piece of pipe to take the chisel and thread the other end for a cap. A compression spring holds the chisel in place—catch one end in the cap threads to keep it from falling out when it's time for you to change chisels.

PETER LEGON, Malden, Mass.



Slop-free way to clean brushes

Paintbrush cleaner you use over and over again is a nuisance to pour back in the bottle. A peanut-butter jar with a screw-on lid is an easy way to use and store the stuff. Paint cleaned from brushes settles to the bottom, leaving clean remover on top, so you can work the bristles against the side of the jar.

JACKSON HAND, Westport, Conn.

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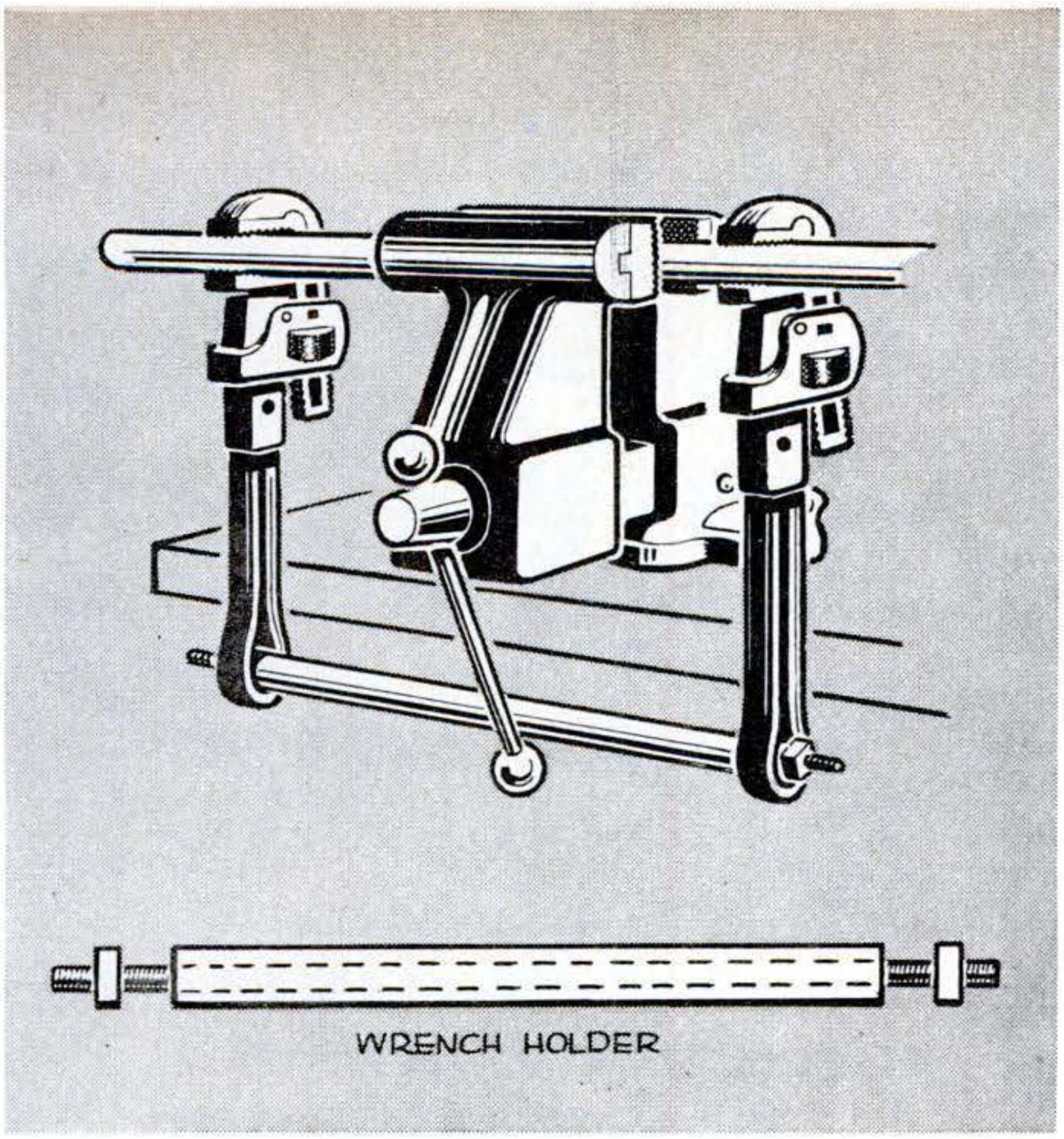

SHORT CUTS AND TIPS

FROM HERE AND THERE

Emergency vise holds pipe steady for threading

An ordinary bench vise won't grip pipe firmly enough to permit threading. But it will if you connect two adjustable wrenches of the same size with a piece of threaded rod and a spacer. Set the pipe in the vise as shown and clamp the wrenches on. Next, rotate the pipe until wrench handles butt against the workbench and grip the pipe. Tighten the vise jaws and you're all set for threading.

PETER LEGON
Malden, Mass.

The only Shark that wears a smile

Larson's Shark 165 doesn't look very ferocious, but then it wasn't named for its looks—just its seaworthiness. And no other boat does so many things so well!

Big enough for an army of fishermen complete with gear, she's small enough to squeeze into those secret fishing holes. Powerful and fast enough for a pair of pleasure-seeking skiers, she's gentle enough for quiet trolling. In fact, Shark is just about the best fishing platform since the invention of the dock—and a lot more versatile!

Even when you're standing on the gunwales, you're on "solid ground" with Shark's unique bihedral hull. She comes with a double windshield and walk-thru dash, forward deck platform, sunbather seats, mechanical steering, storm top, side curtains, stern cover, 18-gallon gas tank with dash gauge, and twin bait wells—all wrapped up in 16 feet of family boating pleasure for **$1395!**

Our new dimension in family boating is also available as a Comboard with a 120 hp. engine at **$3695.**

World's largest builder of fibreglass runabouts

Larson

See why Larson is the hot brand today. For 1968 Buyer's Guide, write to Little Falls, Minn., Petersburg, Va., or Nashville, Ga.

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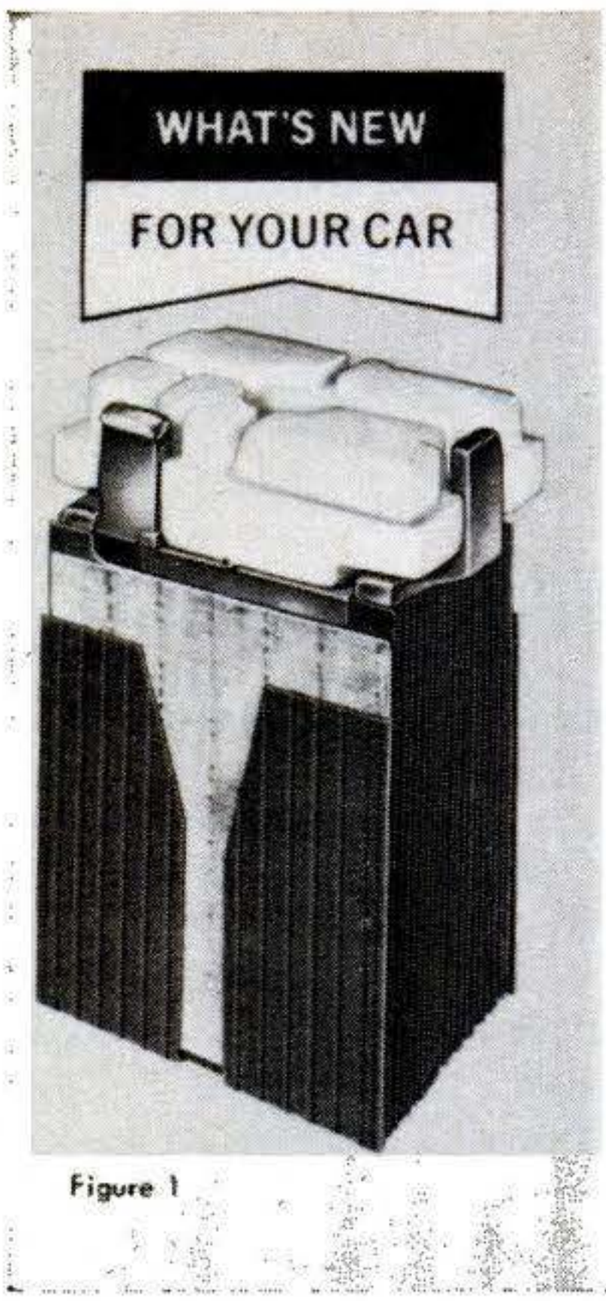


Figure 1

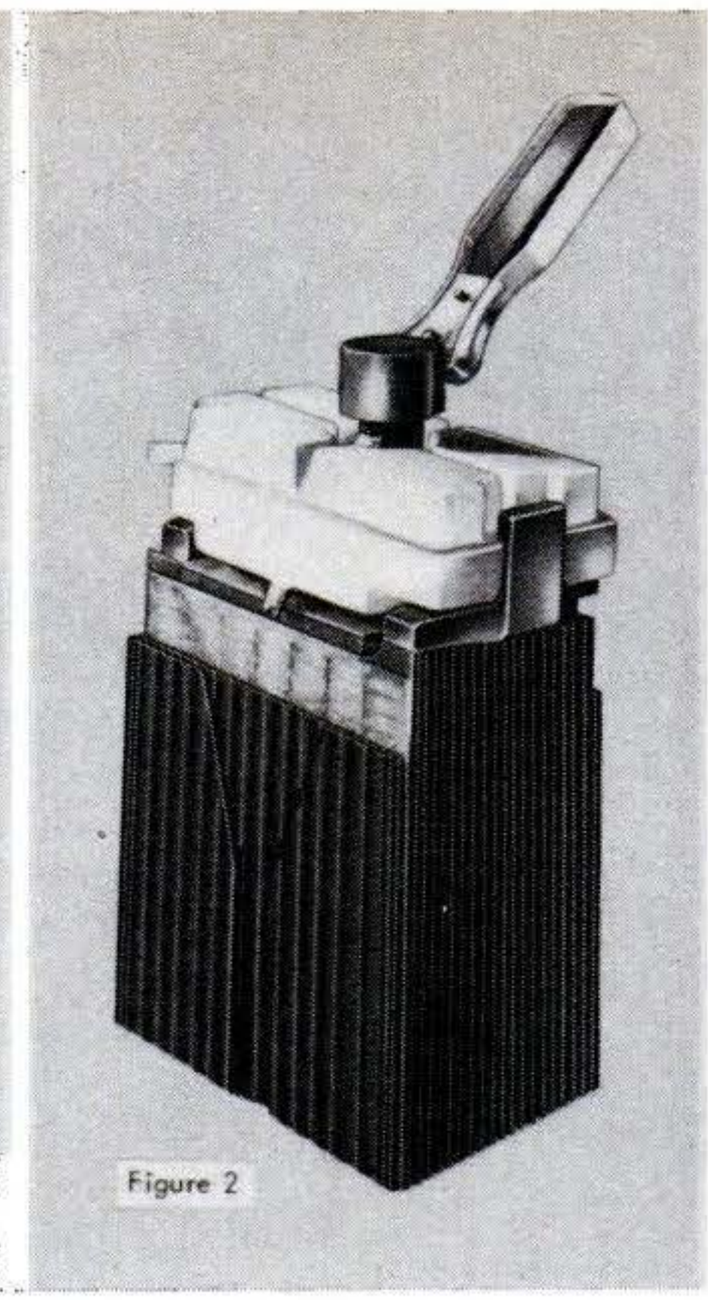


Figure 2

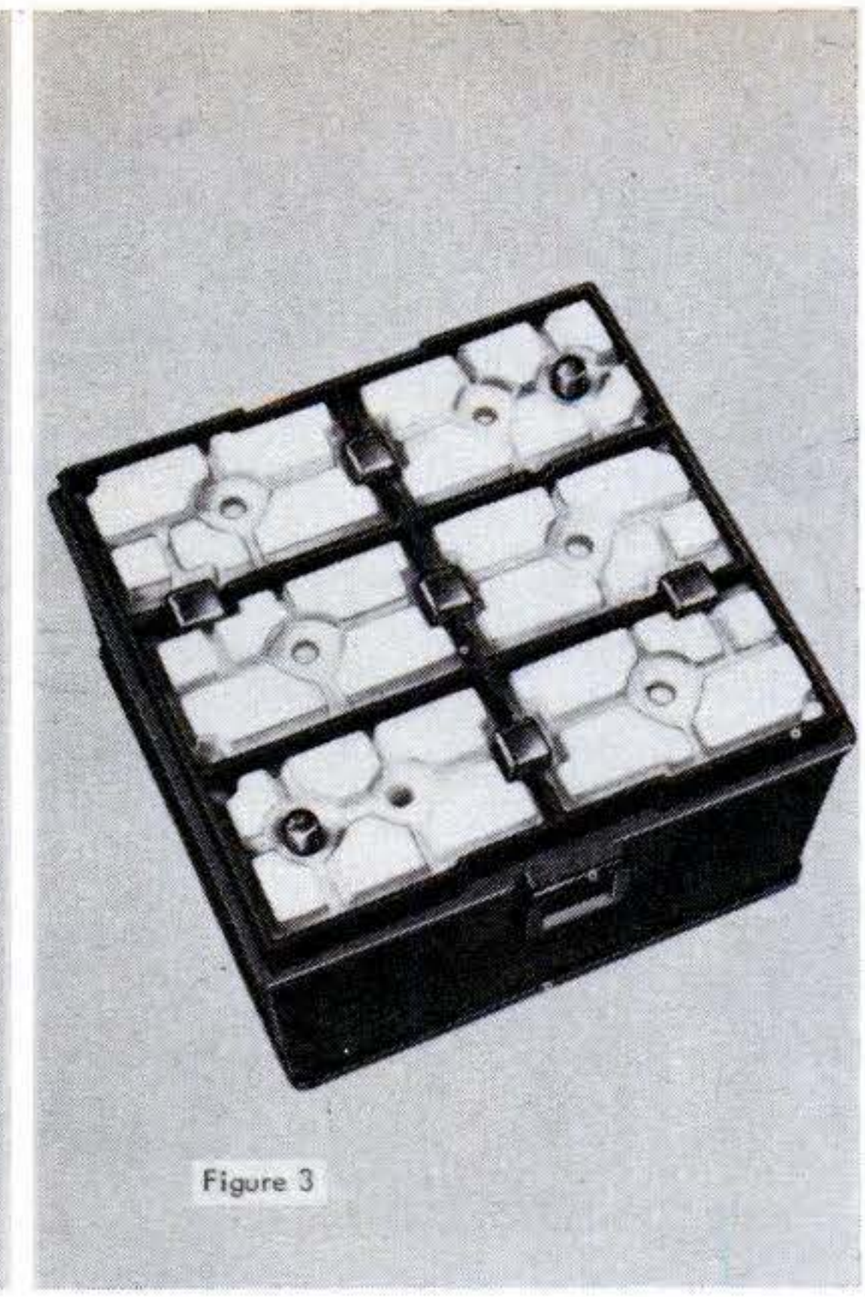


Figure 3

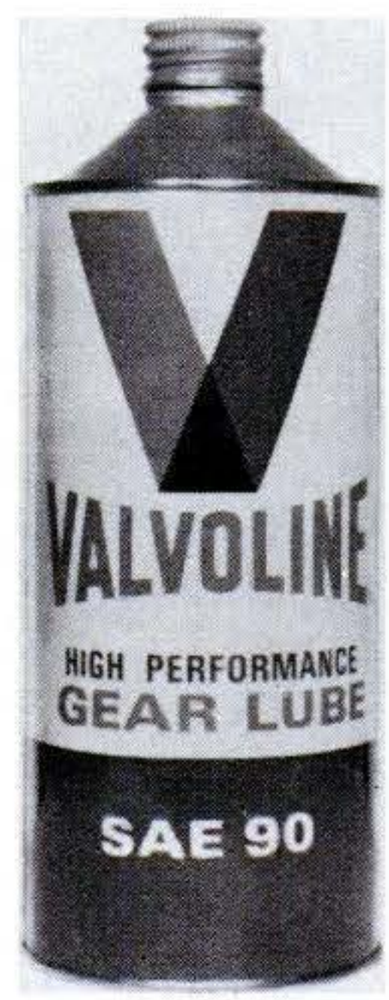
Dry-charged, water-activated automobile batteries are on the way

One hundred pilot models of a new type of battery that can be brought to life by the addition of plain water have been produced by Willard and Exide. Laboratory tests have proved that these dry-charged batteries meet government specifications for comparable batteries activated in the conventional manner (with dilute sulfuric acid) in terms of performance, ampere-hour capacity, starting voltage, and duration of service life. Figure 1 shows a cutaway cell with acid packet in place. Figure 2 shows the puncturing tool used to perforate the acid pack. Figure 3 shows complete battery with acid packs in place, before the one-piece cover is fitted. A battery is activated by filling with water, and then puncturing the acid packs to form electrolyte of the proper specific gravity.

The new batteries are presently undergoing tests by the military.

Race-proved high-performance gear lube offers extra protection when the going gets tough

A new lube (right) is specially formulated for extra load-carrying ability and antiwear, antiscuff, and antifoam characteristics, and is suitable for use in both regular and limited-slip differentials. The new Valvoline gear lubricant exceeds MIL-L-2105B and Ford M2C104A and M2C105A specifications, and is recommended for API services GL-3, GL-4, and GL-5. The lube is packaged in quart cans. It was tested in Indy and Grand Prix cars.



Windshield-washer fluid leaves no streaky or lacy film

A totally new windshield-washer fluid, called Optikleen, is now on sale at Chevrolet, Pontiac, Oldsmobile, Buick, and Cadillac dealers across the country. Developed by chemists at the GM Research Laboratories, it contains a special chemical ingredient that removes visible dirt from the windshield, and also dissolves all traces of organic contaminants, which have been found to be the cause of lacy water films on windshields. The product also contains an ingredient that keeps minerals from precipitating in the tap water it's mixed with. This prevents clogging of nozzles and malfunctions in the washer pump. Optikleen contains antifreeze.

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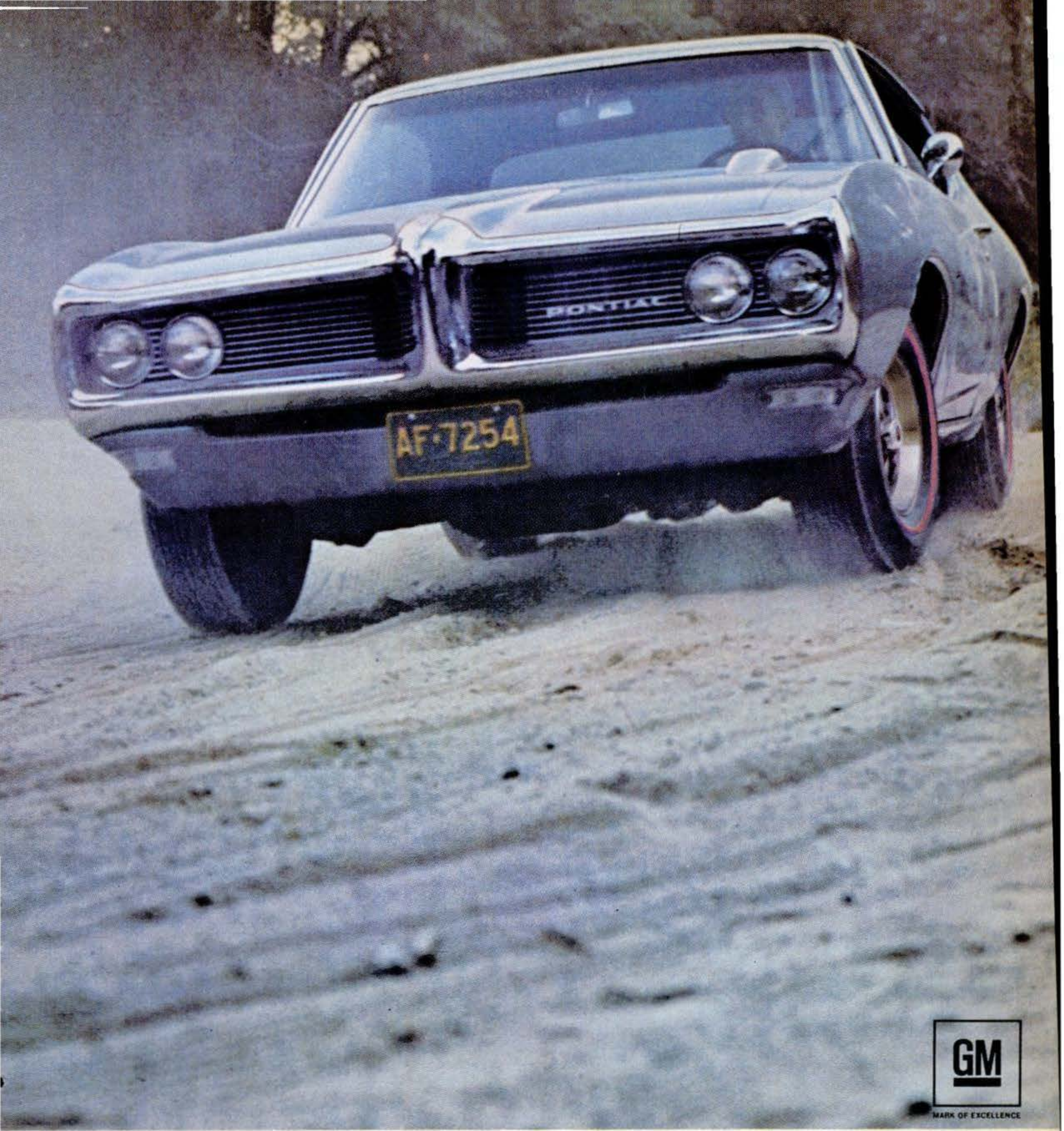

Pontiac Motor Division

Our almost Great One.

There's only one Great One. But being almost as great makes our Tempest Custom H.O. the best understudy in the business. Observe. A new 350-cu.-in., 320-hp V-8. Quadrajet carburetion. 380 ft. lbs. torque. You can option the H.O. to your excitement's content with a floor-mounted 4-speed, Hurst shifter, a special handling package, custom sports steering wheel and others, all for a price you'll have to pinch to believe. These are the reasons H.O.'s irreverent sophistication is in a class topped only by The Great One. But then, what isn't?

Pontiac Tempest Custom H. O.

Specs, decals and 5 color pictures are yours for 30¢ (50¢ outside U.S.A.). Send to: '68 Wide-Tracks, P.O. Box 888I, 196 Wide-Track Blvd., Pontiac, Michigan 48056.

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(smoothest Evinrude of them all)

it delivers priceless days at economy rates

A lot of people consider the 6 hp Evinrude Fisherman to be the smoothest-running outboard ever built.

And because it runs so effortlessly and so quietly—it lasts an extraordinarily long time. Figured on the cost per fishing trip—it qualifies as one of the most economical motors you can own.

An unexpected bonus—since the Fisherman has features not ordinarily found on motors in the fishing class.

Features like full gearshift. Long range plug-in tank. All weather thermostat control. Safti-grip propeller. Twist grip throttle. Sea tight powerhood. And full range sound sealed quiet.

All the things a fisherman ought to have going for him on a day like this.

CATALOG FREE: *See your Evinrude Dealer, or send name and address to: Evinrude Motors, 4051 N. 27th St., Milwaukee, Wis. 53216. (Division of Outboard Marine Corporation.)*

EVINRUDE

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the power behind the fun revolution

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"Racing is like no other sport in the world. It's not like baseball . . . If, in high school or college, you have the makings of a major leaguer, the scouts watch you. [In racing] you have to go it on your own, have what it takes." (Right, Fred Lorenzen, stock-car great.)

STARTED IN RACING

Smokey Yunick has raced cars—briefly. "I stopped," he says, "when I found out that I was a better mechanic than driver." For 22 years he has "set up"—prepared—Indianapolis-type and stock racers, and has a keen eye for what makes a champion driver. Drawing on his rich experience in garage and pit, he tells you here how to get into the sport of racing—and of the drudgery it can entail.

The most common question asked me as I tour the racing circuits with my own car is, "How can I get into racing?" Almost always, that means, "How can I become a race-car driver?"

Okay, I'll tell you. But before we get into this knotty subject, let me deliver a few shockers:

- The "point" champions—the men acclaimed as best-of-breed—are not necessarily the best drivers.
- The world over, about 25 drivers control racing in the sense that they dominate the sport.
- Seven men—mark you, seven—are regularly the front-runners at the Indianapolis 500.
- About an equal number regularly are the front-runners in stock-car racing in this country.
- I have never known a driver who consistently finished in the money who was not also a good mechanic—an expert on engines, suspension, or general design.
- The image of the racing driver has changed drastically in the last 15 years. Most of the men who occupy the cockpits today are of the "junior-executive" type, equally at ease in a business office, a drawing room, or on a speaker's platform.

In light of all that, do you still hanker to get into racing?

Okay. It can be done. Miracles can occur. I can give you some encouragement, but don't blame me if you ignore all that I can tell you about the battle that's ahead of you before you finally sit there in the winner's circle clutching a big, fat check. There have been some naturals in the business. They still pop up. Ever heard of Herb Thomas? At one time he was the undisputed champion of stock-car drivers. Thomas faded. Others crowded past him. That's the way it is with fame.

Thomas was a Down South tobacco farmer. He wore long-handled overalls—the kind with the stripes, you know. He laced his shoes only halfway up. He didn't wear socks. He chewed tobacco, and what passed for teeth in his mouth were in bad shape. Thomas looked to me just like 10 miles of bad road. He had bought a stock car of his own and was banging it around those Southern tracks.

Thomas and I crossed trails accidentally. The late Marshall Teague, one of the consistent winners in stock-car racing, noticed Thomas one day, and decided he might become a pretty good driver. Marshall asked me to get a car fixed up for Thomas for the big race at Daytona.

Thomas was good. He won. The Hudson Motor Car people—Hudsons were hot numbers on the stocker circuits then—were impressed with Thomas, and they

Continued

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asked me to set up cars for him. We had a whale of an operation with Thomas at the wheel. Then the air gap got the best of him.

I'm going to come back to that air gap, and when I do, listen close. It means that a driver has had it.

As a result of the air gap, Thomas drove into a terrible accident. He wouldn't quit when he was ahead.

Thomas' career was one in 10,000. Getting into racing these days rarely happens that way. Now, before I tell you how to get into racing, let me get you straightened out on what a successful racing driver is and is not.

Calculated chances. He is not a daredevil. He doesn't get scared. He takes chances in a dangerous game, but they are all calculated chances. He knows what he's doing. He drives his car; the car doesn't drive him. He's skillful. He has self-confidence. When you see him on the track, driving like the wind and daring to slip through holes in heavy traffic, he's really not working that hard. He's relaxed. Everything that is happening to his car is exactly what he has anticipated.

It doesn't occur to him that he is taking chances. He is by nature two things. He is a businessman in a well-paying sport, like a top-notch ballplayer, and he is absolutely dedicated to racing.

He's smart, he's shrewd. If there's any glamour in the business, he leaves it to others. He is concerned with one thing: getting around that track faster. Right from the first lap, he experiments. He will go into turn number one at a given number of inches from the inside edge of the track, get back on the throttle at a precise point, and see how many engine revs he is registering when he comes out of the turn onto the straightaway. On the next lap he will go in a couple of inches deeper, and on the next one a couple of inches shallower, and all the time he is trying out the point where he bends the throttle again without the excess drift that will cost him speed. If, after five laps, he has improved his lap time by a half-second, he begins analyzing how he can improve *that*. If he hasn't improved, he begins analyzing why. In his mind he chops up the track into little pieces and diagnoses each piece in relation to his car's performance.

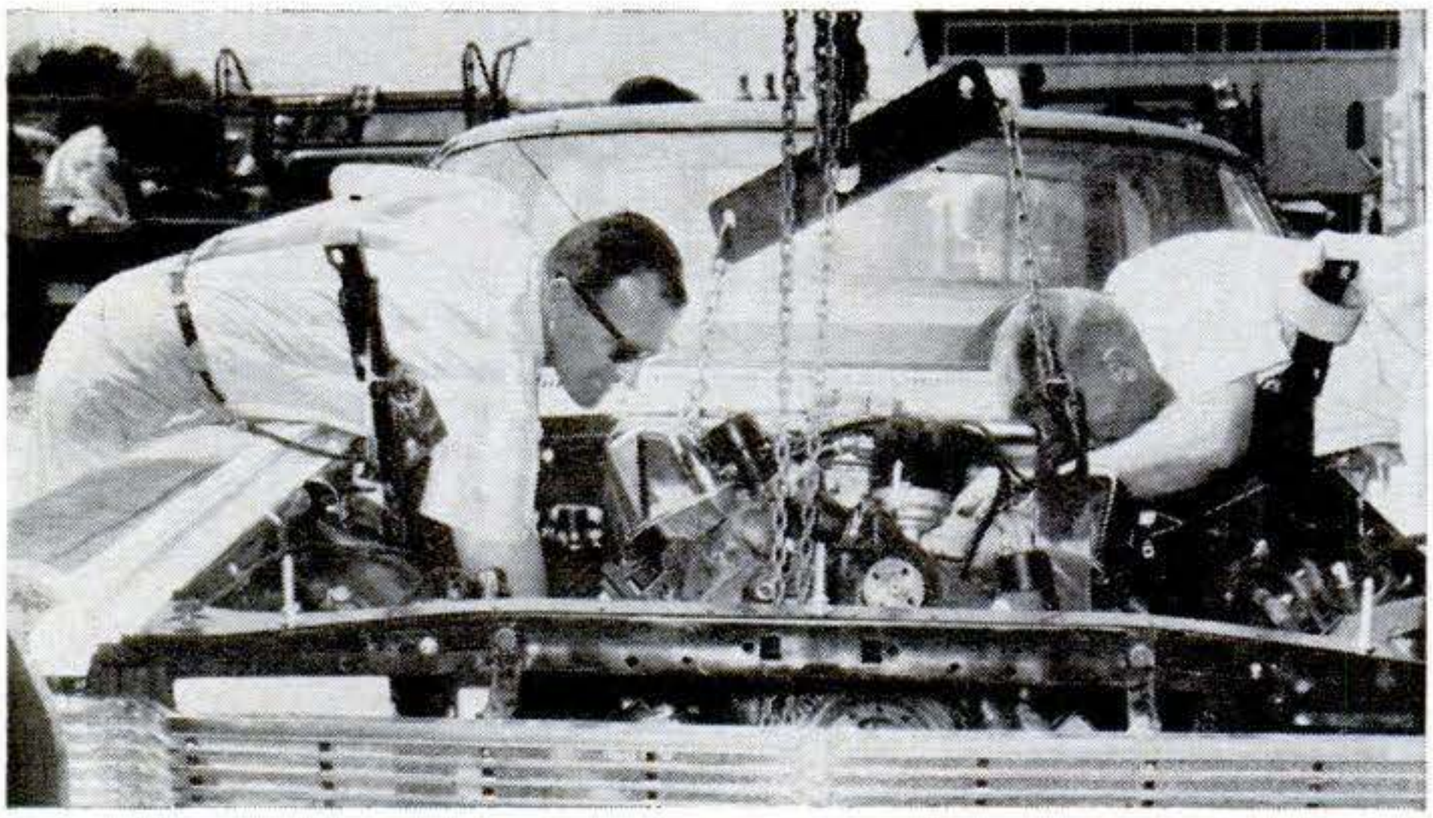
No formulas. So much for the image. Could you qualify? If you think you can, how do you go about getting into racing? It will be far easier for me to tell you what you need in brains, personality, and perseverance than to try to give you a formula. There aren't any formulas.

The traditional dream of the youngster in the stands, watching a race, is one of working as a mechanic in the pits when, suddenly, opportunity knocks. The car owner says to the bright-eyed young man, "Smith is ill! You'll have to take over the wheel!" Well, it doesn't happen that way.

Don't mistake me. I *want* you to get into racing—if you've got what it takes. Racing needs dedicated men. The champions age fast. But I would be less than honest if I didn't tell you what's really involved.

You can get into racing by learning to be a top-flight driver who also has learned to be a fine mechanic, or by owning a racing car. Owning a car takes money, lots of it. The hard way to get into racing—and 99 percent of the men in it do it the hard way—is to start sweeping the floor in a garage. Work into becoming a mechanic's helper. This won't pay anything. You'll starve. You'll no doubt make a number of tries before they even hand you the broom.

If you walked into Holman & Moody's shop in



"A. J. Foyt . . . being the shrewd and talented man he is, winner not only of the Indy 500 in '67 but of Le Mans as well, is a wealthy man."

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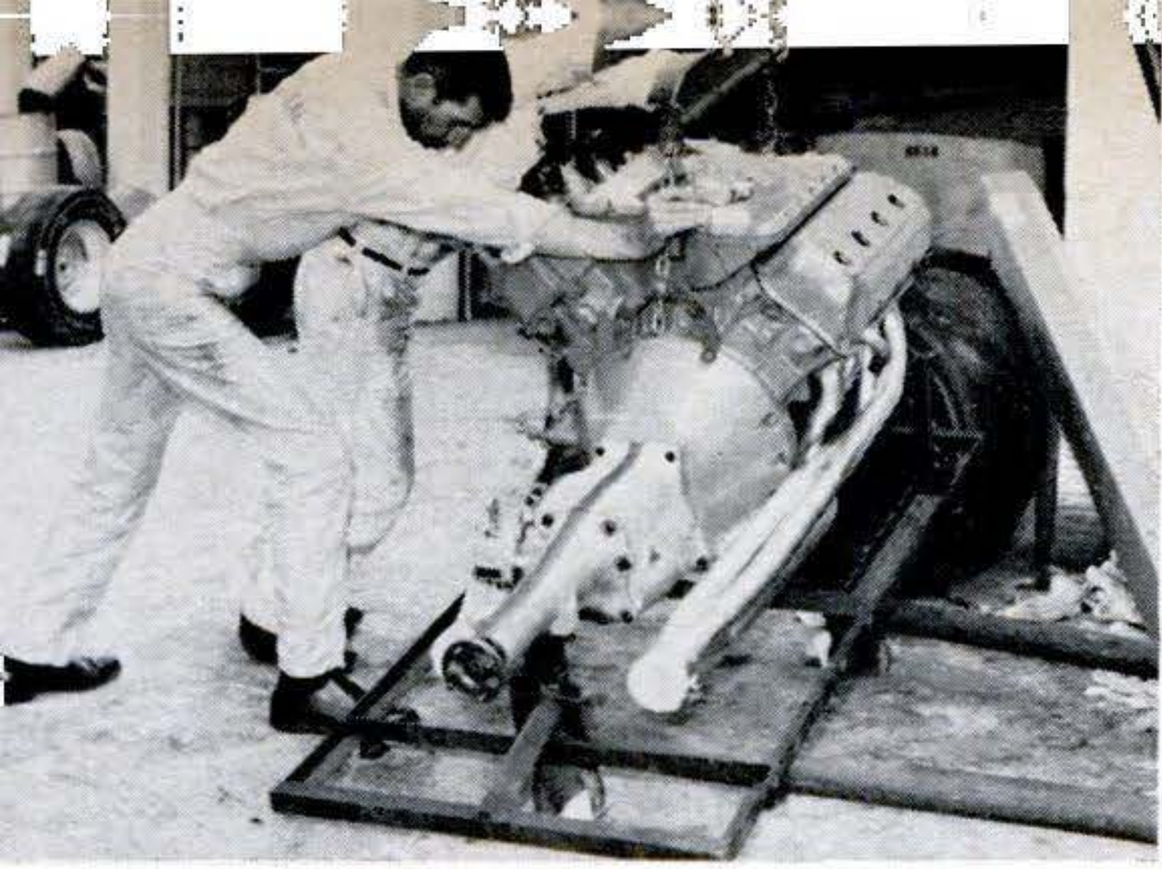

"Just 13 days from the time Paul Goldsmith shoehorned himself into a roadster, he qualified."

"The image of the racing driver has changed in 15 years." (Above, right: Lee Roy Yarbrough.)

Charlotte, N.C., where they build stockers for Ford Motor, and applied for a job, they would ask you, "What's your background?" If you replied, "None, so far," they wouldn't give you a second look. At that shop eight out of every 10 mechanics have had years of experience on racing cars. Most of them—keep this in mind—are retired drivers.

So, absolutely determined, you go to another shop and you wind up with a broom, working for maybe $50 a week, 16 hours a day, seven days a week. Now you find out that the outfit is underfinanced. Most of them are. Suddenly you're off the payroll, and out looking again. You connect once more. Maybe you're beyond the broom stage now. You're allowed to lift and tote, and watch the mechanics work. You sacrifice everything to your dream. You put up your youth, your comfort, your relationship with your family—everything—as collateral to satisfy your obsession. To learn, if you're lucky enough to get into a cockpit, you drive junk for a couple of years.

Miracles can happen. And then, one day—oh yes, it *can* happen—the regular driver gets sick, or gets hurt, and you're allowed to take the car out on a shakedown. Someone says, "Hey, you're pretty good!" And brother, if you're born to race, that's just about the sweetest music this side of heaven!

Racing is like no other sport in the world. It's not like baseball, for example. If, in high school or college, you have the makings of a major leaguer, the scouts watch you. You even find some money coming your way to further your education. But racing doesn't have any scouts watching academic performances, or up-and-coming guys in the minor leagues. You have to make it on your own. You have to have what it takes.

Richard Petty has what it takes. He was a lucky man to have Lee Petty, a crackerjack racing driver a few years ago, for a father. Lee taught him to race. But Richard Petty has three other vital attributes: He's smart, he's a fine mechanic, and he is absolutely dedicated to racing. A. J. Foyt also has what it takes, but he was lucky, too. He had a father who was a race fiend—not a good driver himself but nutty about the sport. He financed his son into midget racing, and Foyt, being the shrewd and talented man he is, pretty soon found that other people were ready to bank money on him. Today, Foyt, winner not only of the Indianapolis 500 in 1967 but of the Le Mans race as well, is a wealthy man from his track efforts.

Mario Andretti had some family money behind him, but after he got started in minor-league racing in Italy, he made it on his own. Jim Clark of England may be the outstanding example of how to make it on your own by sheer skill and determination. Fireball Roberts, who died in racing, was another determined guy. He tried and tried to get into racing. Nobody would hire him. So, like a lot of men of great passion, he borrowed and begged, and left a trail of unpaid bills behind him—which he paid up when he got into the money—and built his own car. The rest is history.

Dan Gurney got where he is by knowledge and skill.

[*Continued on page 186*]

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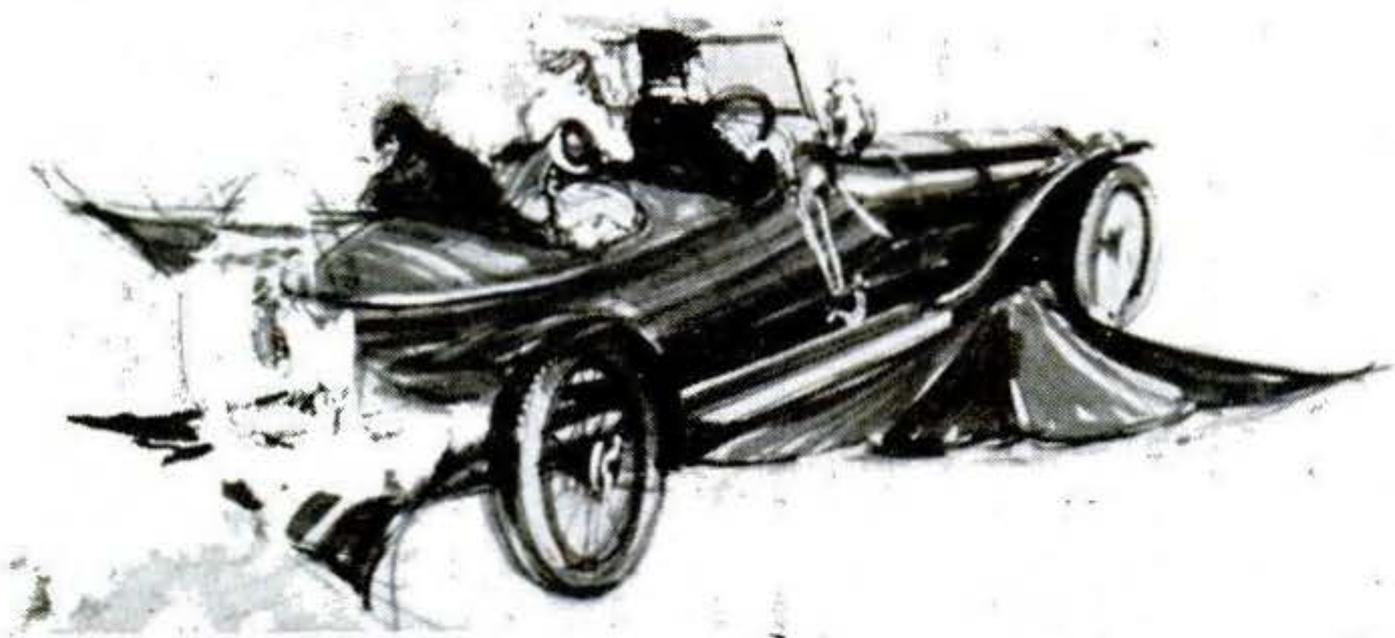
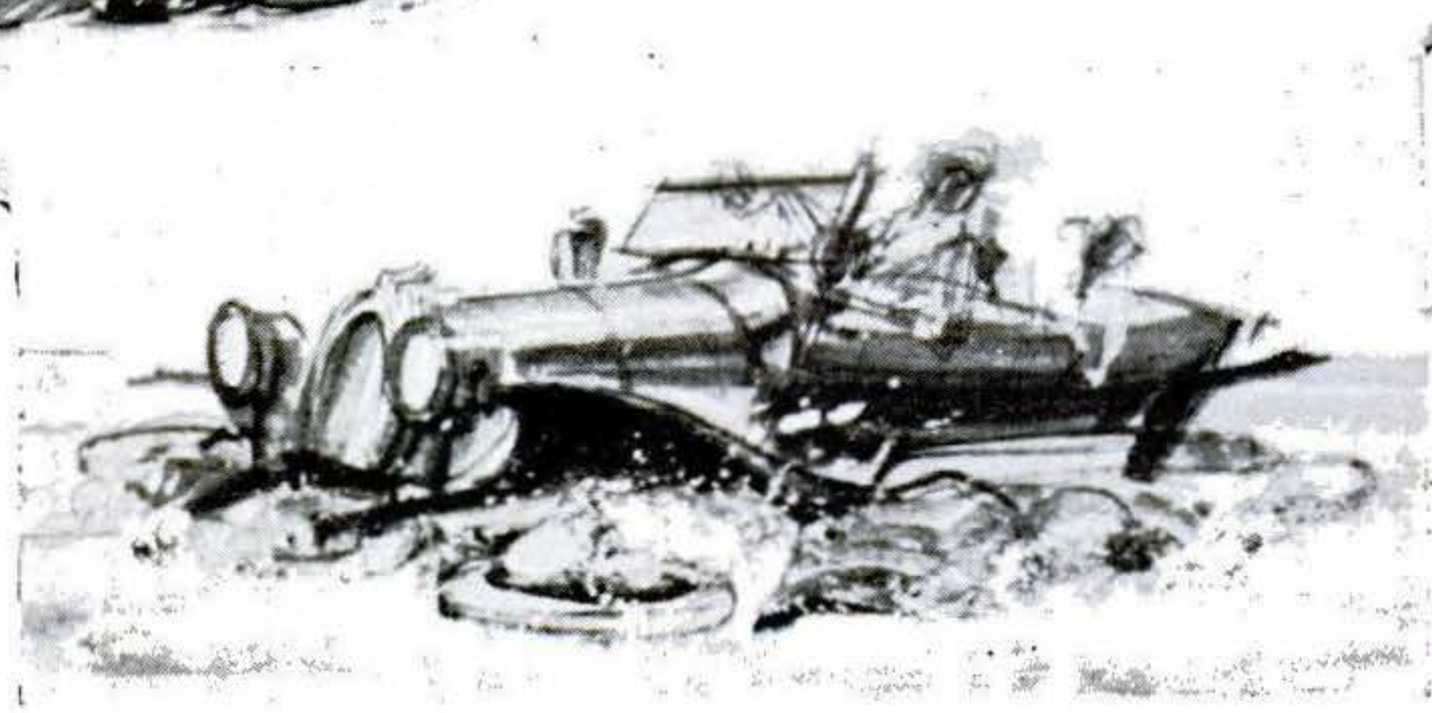
Dick Van Dyke Drives the Zany Chitty Chitty



Getting away from crooks is easy in the goofy car. By means of a little special-effects movie magic, Chitty spreads its wings, extends a propeller, and flies off into the blue yonder—helped by an invisible cable.



Water obstacles are overcome by Chitty; it turns into a hovercraft. The only thing real, though, is the spray. A scissor jack, hidden by the water, holds it up and makes it look like a fast air-cushion vehicle.

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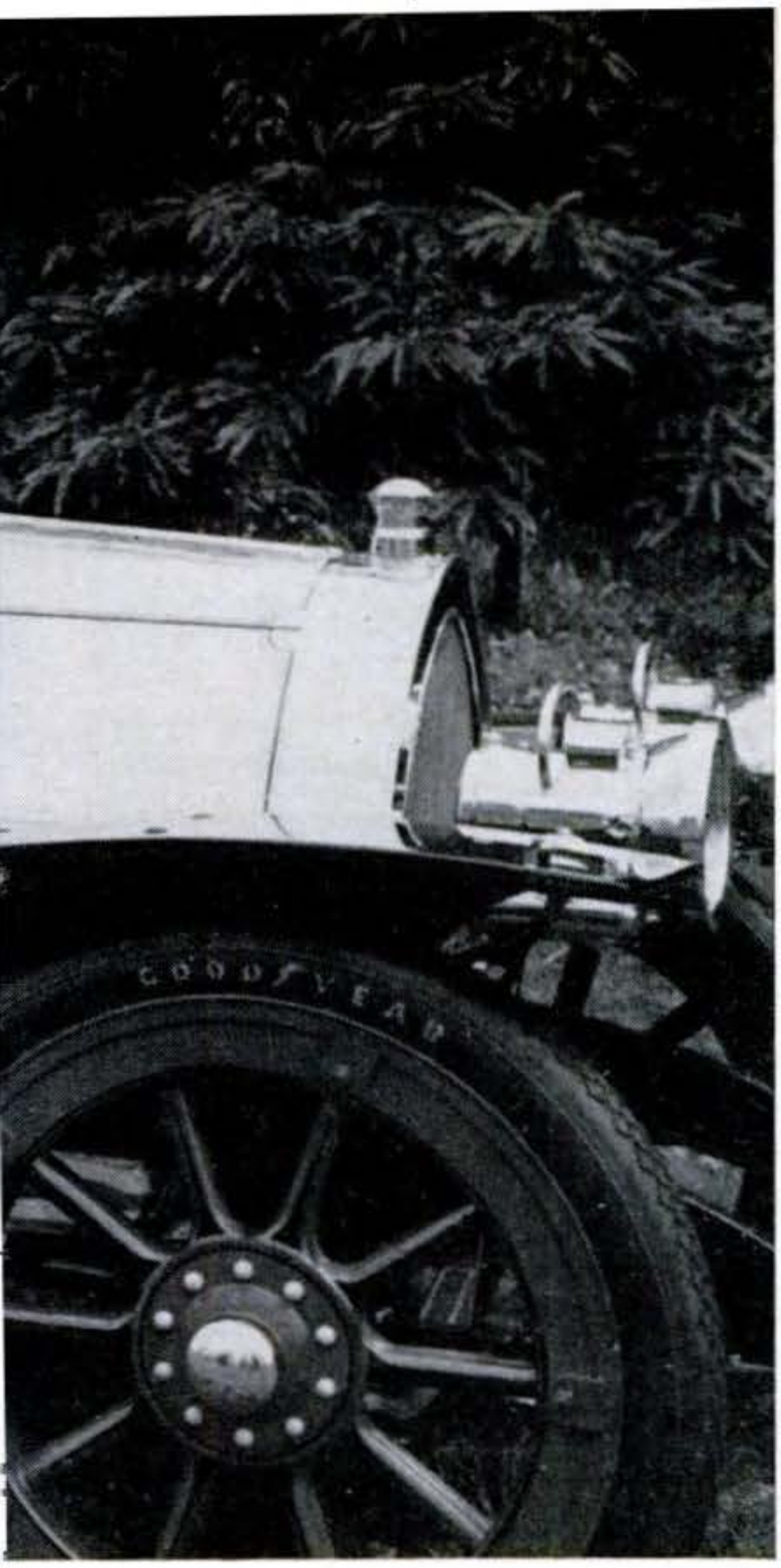


Dick Van Dyke and Sally Ann Howes, who are co-stars, are shown with Chitty Chitty Bang Bang on English movie set.

Bang Bang

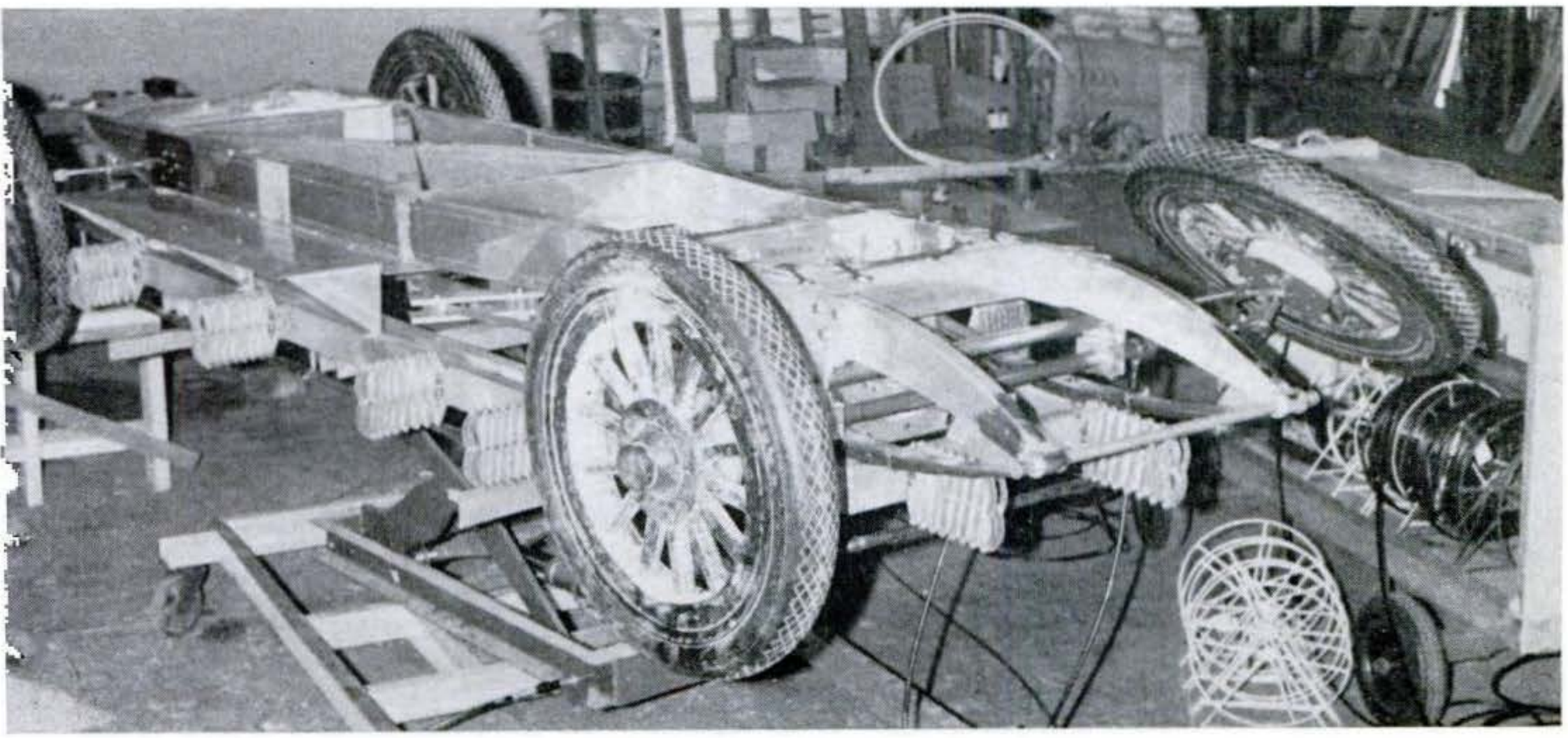
Moviedom pulled out all the stops in creating this wacky auto, which turns into a flying machine or hovercraft, and does 100 m.p.h. on wheels

When Dick Van Dyke signed to play the starring role in *Chitty Chitty Bang Bang*, he may not have bargained for the ride he was being taken for —in what may be the weirdest auto ever to come off a design board.

The movie is based on a children's book by Ian Fleming, writer of the James Bond novels. "Chitty Chitty Bang Bang" is also the name of a car—that's the sound it makes when it's driven. Chitty —the car, that is—was built by designer Ken Adam, who created the wild gadgets for the 007 movies. In fact, he designed seven different chassis to do all the things Chitty has to do to help Van Dyke escape a gang of villains. Chitty is supposed to do 100 m.p.h. on hard-rubber wheels, and actually does achieve that, powered by its Ford V-6 engine. It's also supposed to fly and turn into a hovercraft as necessary, and it does that also—by means of special effects. The flying-machine chassis spreads wings and extends a prop for flight—but actually it's suspended by an invisible cable.

The hovercraft version is supported by a scissor jack on a rolling trolley covered by water. Hydraulic actuators make its wheels tilt horizontally and air jets create a spray.

Top star of the movie isn't Dick Van Dyke, but the magnificent Chitty Chitty Bang Bang.



One of Chitty's "transition" chassis is shown above. Note how wheel at right has been thrust outward and is nearly horizontal for hovercraft effect. Extensors (coiled objects) unfold hovercraft skirts.

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KARATE!

How I Became a

By ROBERT GANNON PHOTOS BY ORLANDO GUERRA

New *gi* suit, the uniform for Karate practitioners, is timorously tied on by Gannon. Beginners wear a white belt. Those more advanced earn green, brown, and finally the coveted black, belts.

I don't *look* frightening. But you better watch out. I've just finished a four-month karate course, and if you've got any boards around that you don't want smashed, hide 'em. I may not be able to hold myself back.

Board-breaking, in fact, started it all. Two Netherlands professors say the only difference in striking power between a karate expert and a layman is guts. If the novice had the nerve, they concluded, he too could break boards. Having always been inept with an axe, I decided to take a course in board-breaking.

So I find myself climbing a long narrow stairway to Yun Mu Kwan ("where warriors gather to study") Karate Institute in Manhattan's Greenwich Village. Grunts are coming through a door that bears a sign: PLEASE TAKE OFF SHOES. I comply and enter.

A short man with a shaven head, solid as a stump and wearing what looks like a white bathrobe tied with a black belt, is doing a ritualistic dance in slow motion. He is Min Q. Pai, 32, Master of the school, who invites me to stay and

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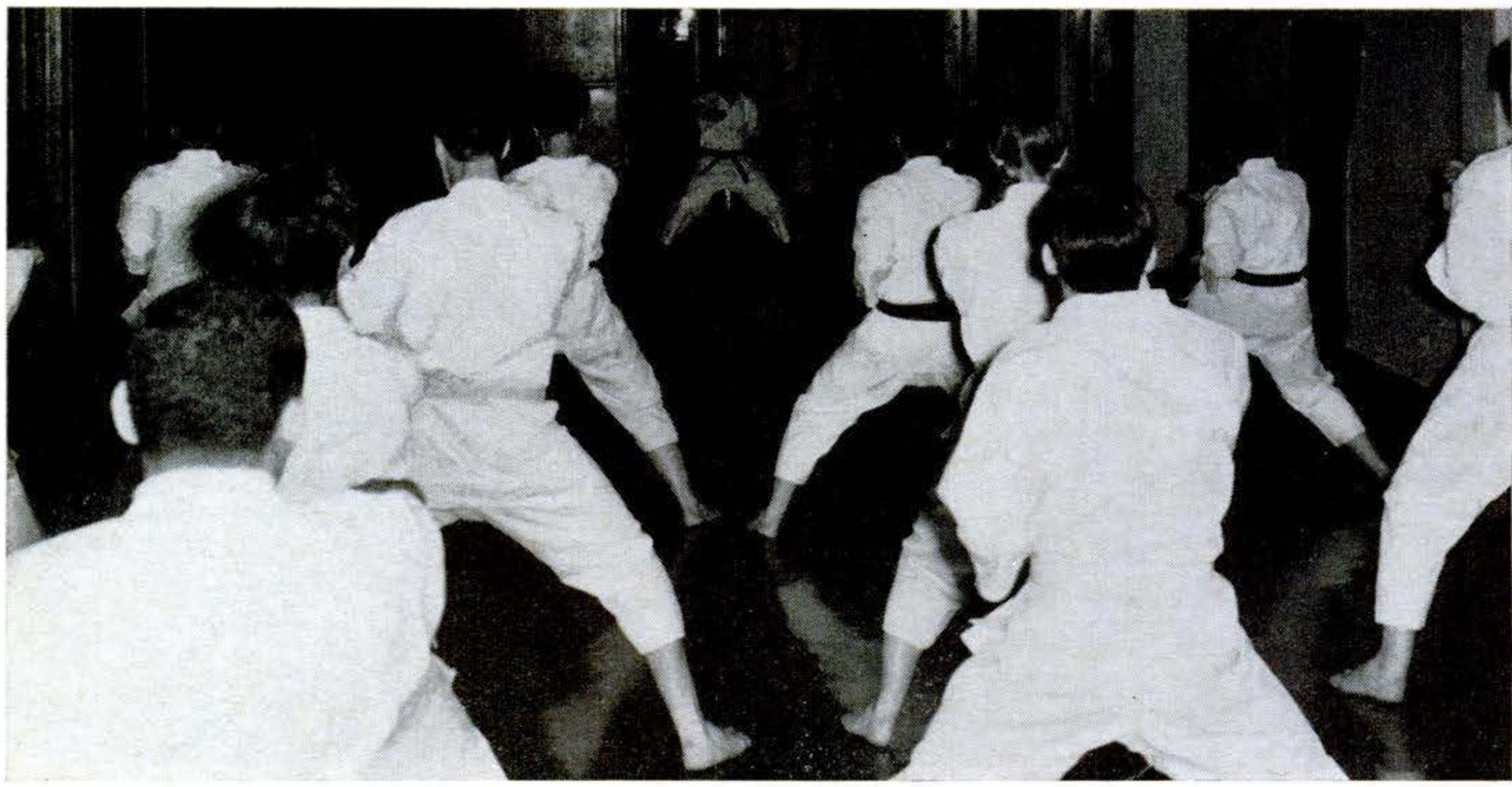

Karate master Min Q. Pai leads class in practicing basic *ma-se*, or horseback position.

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Oof! Ouch! Ugh! PS' Go-anywhere, do-anything reporter learns how to break boards and other karate tricks that turn average guys into tough fighters

Deadly Walking Weapon

Up-up-up-ugh! goes reporter Bob Gannon as he practices a flying leap in which his right foot is headed for an opponent's back. If the kick is blocked, his left hand is clenched to follow through with a blow to opponent's head. Practice blows don't actually land, though, because if they make contact, they will break bones. Practice is done to perfect forms.

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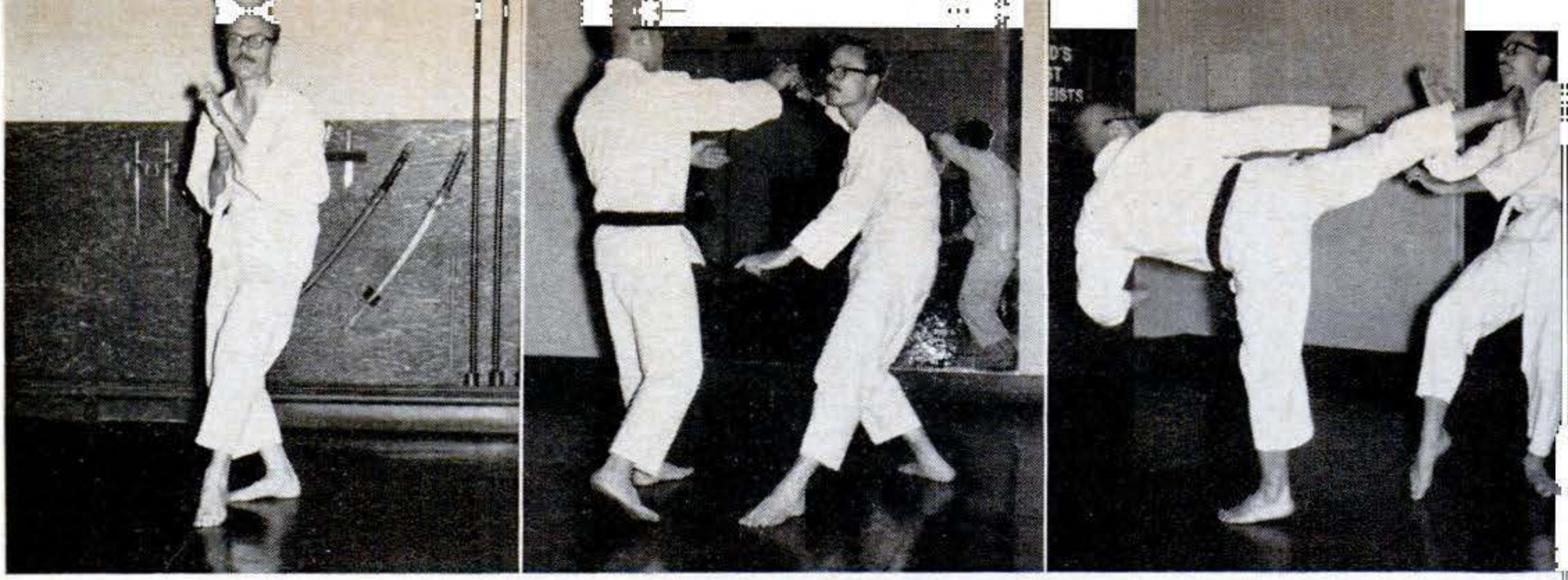

Gannon takes basic stance (left) as he advances toward Pai. Gannon's right is blocked by Pai

watch a class. I wait, and soon the hall is bouncing with lots of guys and a few girls kicking and slashing and punching imaginary opponents.

Then everyone does slow-motion dances, calisthenics, basic karate maneuvers, and stylized "forms," or *katas,* punctuated with cries of "Yaah!"

The evening's climax is a half-hour of free-style sparring. But no one lands a blow. Pai explains: "They cannot make contact. If they do they will break bones."

What is karate? Karate, he says, consists of blocks, punches, and kicks delivered with enormous force. "It is purely defensive," says Pai. "But when you *do* decide to defend, the first blow must break something."

I put a game look on my face, flex my skinniness, and announce that I'd like to join—and learn to break boards.

"Show biz," Pai retorts. "A board is not a bone."

Enrollment fee is $35, with dues of $25 a month. Classes are held for three hours every weekday night. But I could make it only once a week.

"Your mind will forget. Your body will forget," says Pai. He is right.

My first class. Next week, dressed in my new $7.25 *gi* suit, including the beginner's white belt (others, farther up the proficiency scale, are green, brown, and black), I arrived for instruction.

"Your arms are hoses with the water running out of your fingertips," the master began. "Your hand is an arrow in flight; it has no energy; but when it *strikes,* then it penetrates. Your body is a whip—weak in itself but strong when focused. You will learn to know your body so well that when a fly lands on your shoulder you will feel off balance."

We ran through a few basic stances—all extraordinarily awkward, stretching muscles my thigh fat had long ago hidden—and kicks threatening to tear obstinate tendons asunder.

The Karate punches. Emphasis was on the basic punch from a *ma-se* or horseback position: a low squatting straddle with the feet wide and parallel and the hips thrust forward. You hold one fist straight out in front, with the other fist, fingernails up, tight to your hip bone. As you jerk back your forward fist, you shoot forward the fist at your hip, and just as it reaches the imaginary target, your hand turns over to strike between the first and second knuckles.

"Keep your body straight," said Pai. "Hold your toes parallel. Don't wind up. Wider stance. Get lower! Squeeze your rear. Squeeze! Pull your forward hand back hard!"

So I smacked myself in the belly. During a blocking maneuver, I slammed my knuckles together. During another block I hit myself in the nose and sent my spectacles flying.

Not used to spinning around on bare soles, my feet blistered; then the blisters broke as perspiration made the floor sticky. I did well to get home unaided.

The next morning I awoke one enormous crick. But I recovered just in time for my next weekly class. And that ruined me for another week. And so it went.

Meantime, I was finding out just who takes karate and why. My classmates and their reasons for enrolling were surprisingly varied. A small, flimsy guy whose face says "push me"; a Black Muslim, aloof and brooding; a young beauty who is afraid to walk New York streets; a cop with a tough beat; a bus

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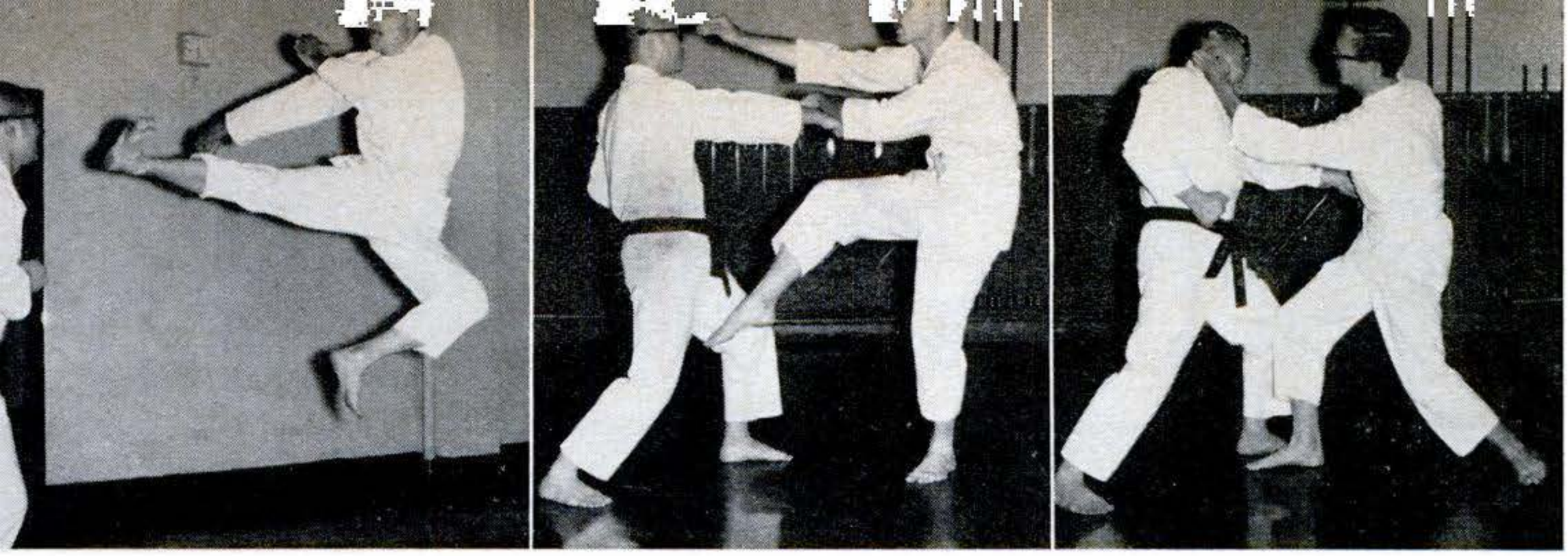

who kicks him on chin. Gannon misses with flying kick, but lands a chop to clavicle (right).

driver whose late-night route scares him silly; a bank teller; a classical-guitar teacher; a guy who runs a dating service; and a pacifist who once came to class late because he was on a peace march.

Offered a high-school teacher: "Karate probably acts as a mixture of physical therapy, religion, and group psychiatry."

Ages ran mainly from mid-teens to late 20s, but one 10-year-old kid from Argentina earned his green belt shortly after I began, and one puffing guy in his late 30s was attending because karate helps his asthma. Oddly, I saw no one I could classify as a young thug. The reason, said Pai, is that either the hoods change, or they don't stay.

I'm learning. As the weeks passed, I progressed. I could take a stance without having the urge to fall. I began to feel less awful after class. My *katas*—basic movements of punching, blocking, and kicking—were shaping up nicely, and during the week, whenever my neighbors caught sight of me fearsomely dancing around the yard, they trembled.

During part of each session, students paired off to practice lunge and blocking exercises. The whole thing in karate, I found, is reflex action, speed, and knowledge of anatomy. When someone moves to strike you *here* you automatically block like *this* and automatically deliver a blow *there*. For example, a student might simulate a *shuto*—an open, stiffened "knife hand"—to the collarbone while his opponent counters with an upper-arm block followed by a punch to the chest and a slash to the throat.

My first match was a revelation. I suddenly realized I had never thrown a punch at anybody before, that all the little fights I had as a kid were merely wrestling matches. I also found that under stress I forgot everything I had learned. Instead of falling into an oriental stance I found myself mimicking American boxers.

"It always happens," said Pai. "Americans have a terrible time; they always want to hunch their shoulders and wind up for punches and duck." In karate, instead of dodging, you block.

"Punch!" My opponent, fortunately, was a brown belt who knew what he was

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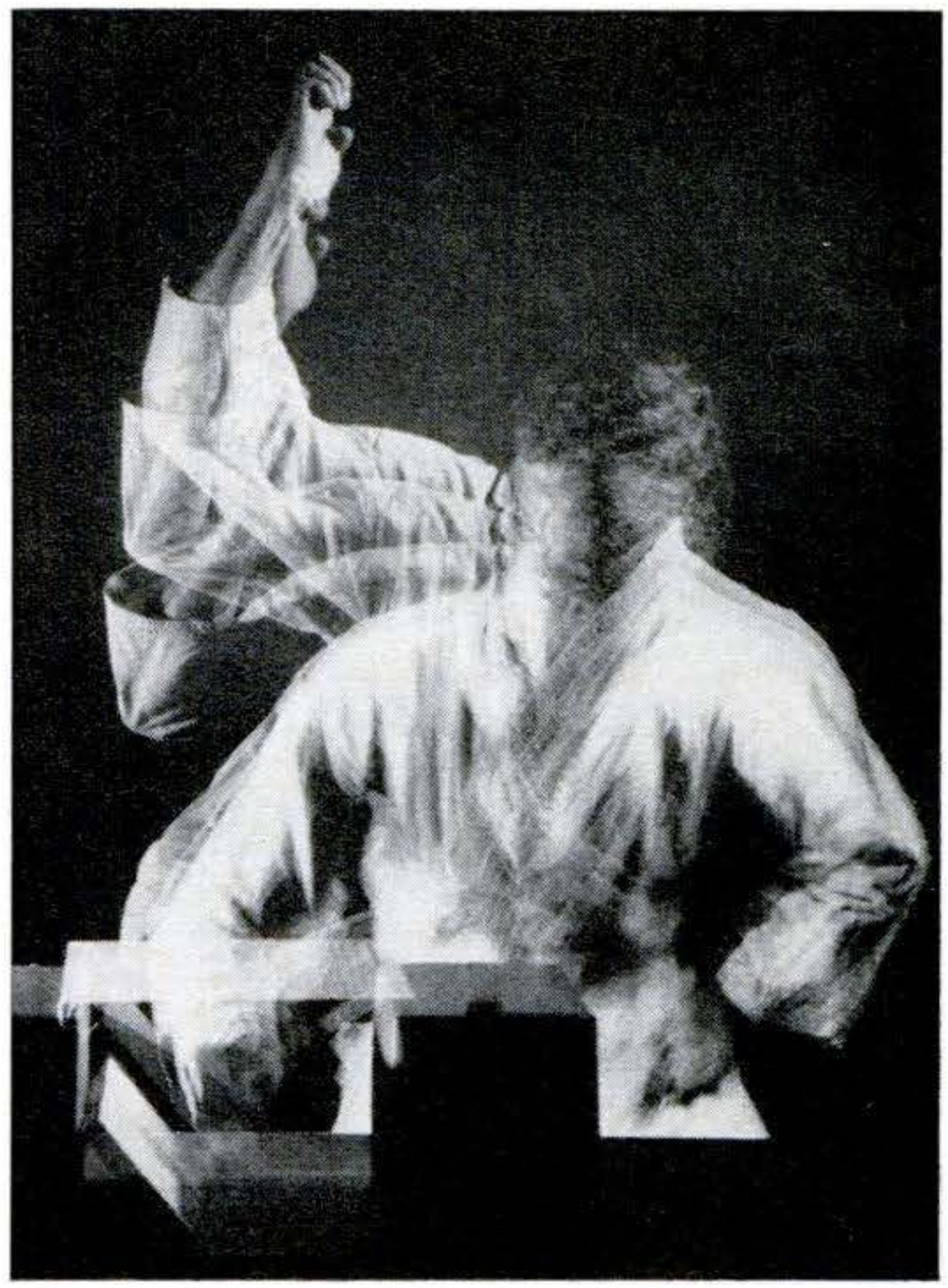

In a concession to show biz, Gannon's final exam includes breaking a board with his bare hand. Gannon broke knotfree ¾-inch pine board with a single chop, but he flunked the rest of his test.

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Army's 250-m.p.h. Chopper

Highly maneuverable, Cheyenne has 360-degree swiveling gun turret, carries grenades, rockets.

Hundreds of the new craft, for use as gunships on troop-support missions, are on order —at $1 million a copy

Out of Lockheed by way of the U.S. Army has come a "third generation" helicopter, born just a quarter-century after this type of flying machine came of age. Its performance is stunning.

• Its speed is 100 miles an hour faster than that of any rotary-wing aircraft

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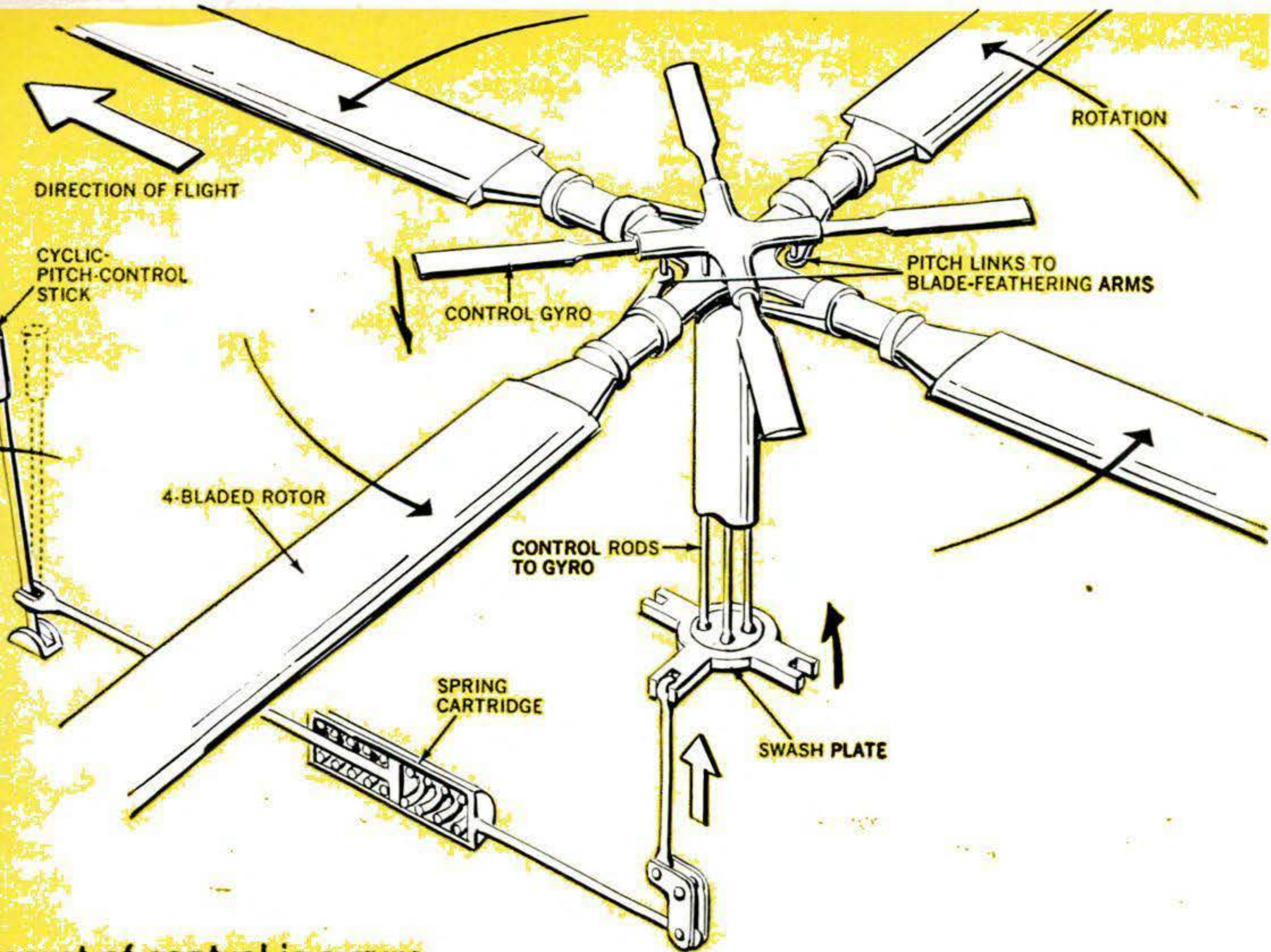

ecret of control is a gyro

op rotor mast is small gyroscope—heart of control stem. To fly forward, for example, pilot moves cy-ic-pitch control stick forward. This loads spring rtridge to exert force (white arrow), but not move-ent, on left side of swash plate, connected to gyro rods. Pressure causes gyro to precess (tilt) 90 degrees later. Plate moves with it (dark arrow). Pitch links to rotor blades' feathering arms then ex-tract more lift from blades in rotor's rear quadrant for forward flight. Rotor, itself a gyroscope, pre-cesses with control gyro. Blade pitch changes con-stantly to equalize lateral lift and for propulsion.

Can Loop and Roll

By DEVON FRANCIS

now in service, Lockheed engineers say.

- Most of the teeth-jarring vibration associated with copters is gone, making it, in combat, a stable gun platform.
- It thinks it's an airplane—it can loop and roll.
- Finally, the new chopper can streak from hovering at zero forward speed to 230 m.p.h. in 38 seconds—and decelerate from that to zero hover in 17.

The Army has ordered the craft in the hundreds—at a million dollars a copy.

The projected commercial versions are even more fantastic. These airliner choppers could be in the air within three years, carrying passengers from city center to city center at 500 m.p.h.

A third generation of helicopters? Yes—prototypes in the mid-thirties and early forties pointed the way toward today's machines. The second crop got its long pants in the Korean war. Now, on the third go-round, the chopper shows a promise that its originators may never have dreamed of.

The performance of the new rotary-wing craft is due almost solely to a change in the blade attachment that has been in use for more than 45 years.

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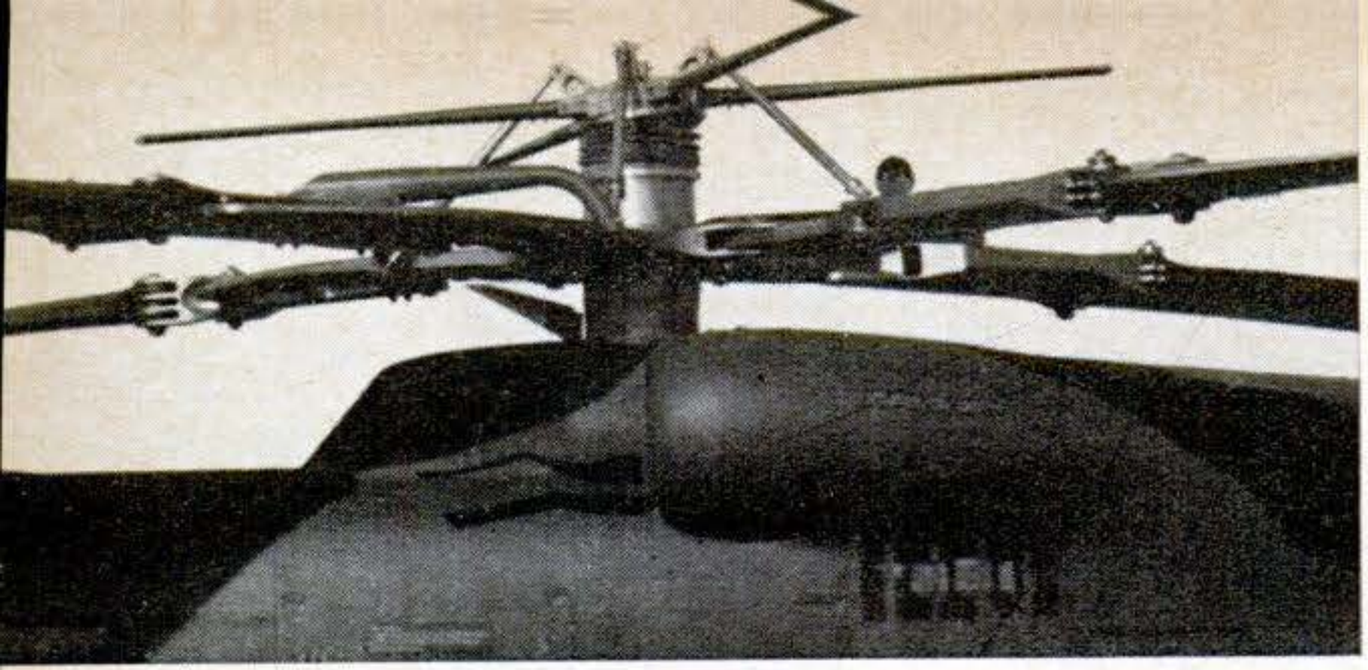
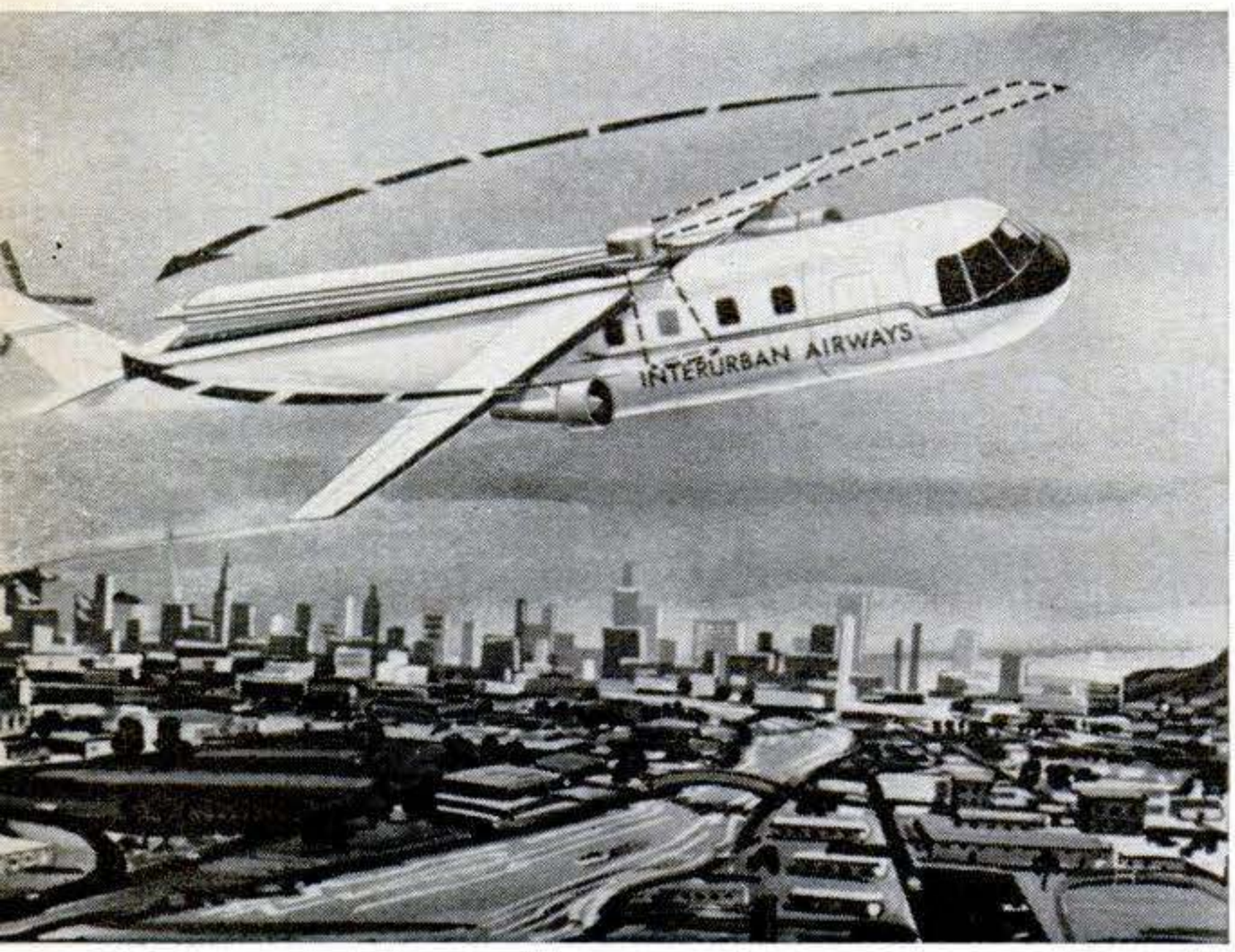


Spidery diagonal rods leading from control gyro to blades are pitch links. Cheyenne can reach height of 26,000 feet—extraordinary for a chopper—and with reserve tanks can fly 2,800 miles nonstop.

Antitorque tail rotor and pusher propeller each have 10-foot diameter. Rotor diameter is 50 feet, 4.8 inches. Span of fixed stub wing is 26 feet, 8.4 inches. Chopper's design weight is 17,000 pounds.



High-wing commercial version is planned by Lockheed for travel up to 500 miles from city center to city center with 30 passengers. Two jet engines, folding blades, will give it 500-mph. speed.

Mainly responsible is an authentic genius who never went to college.

Looking backward. The story of the new generation really begins with a Spaniard, Juan de la Cierva. Cierva had figured out how to whip one of the mountainous problems posed by flight with whirling wings. That was torque, the same thing that causes your car engine to rock in its cradle in the direction opposite to the rotation of the crankshaft when you step on the gas.

When power is applied to the helicopter screw, torque makes the fuselage want to whirl in the opposite direction. Cierva whipped torque by *not* applying power to the rotor. He let his canopy of blades auto-rotate and used an ordinary piston engine and conventional propeller to pull his contrivance forward.

The theory was fine, but his machine capsized before it was airborne. That was because of another nutty thing about rotary-wing flying machines—the blades advancing toward the line of flight in their circuit of the hub generate a lot more lift than those retreating from it—the difference in direction of the air stream on them is 180 degrees.

Cierva finally devised a fix for that, too. He put horizontal hinges at the blade roots so the advancing blades rose and lost lift and the retreating blades fell and gained lift. And that produced another problem: The blades kept slowing down and speeding up because, as they rose and fell, the distance of the center of each blade's mass from the hub shifted back and forth. That put terrific strain on the blade roots, and on the whole blade structure. So Cierva added vertical hinges—lead-lag hinges.

Now he had it. The result was the Autogiro, which made history.

But the hinges, used since Cierva's time on almost all rotary-wing machines, including helicopters (where power is applied to the canopy of blades for both lift and horizontal propulsion), created tremendous vibration, with all that flapping and fore-aft swishing.

Choppers are skittish. In combat, gunners aboard them have to use "Kentucky windage" to hit a foe. Until now, the speed of helicopters has been limited. If they got to going too fast, the retreating blades encountered "stall"—practically

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Photosprint: a combination of optics and electronics

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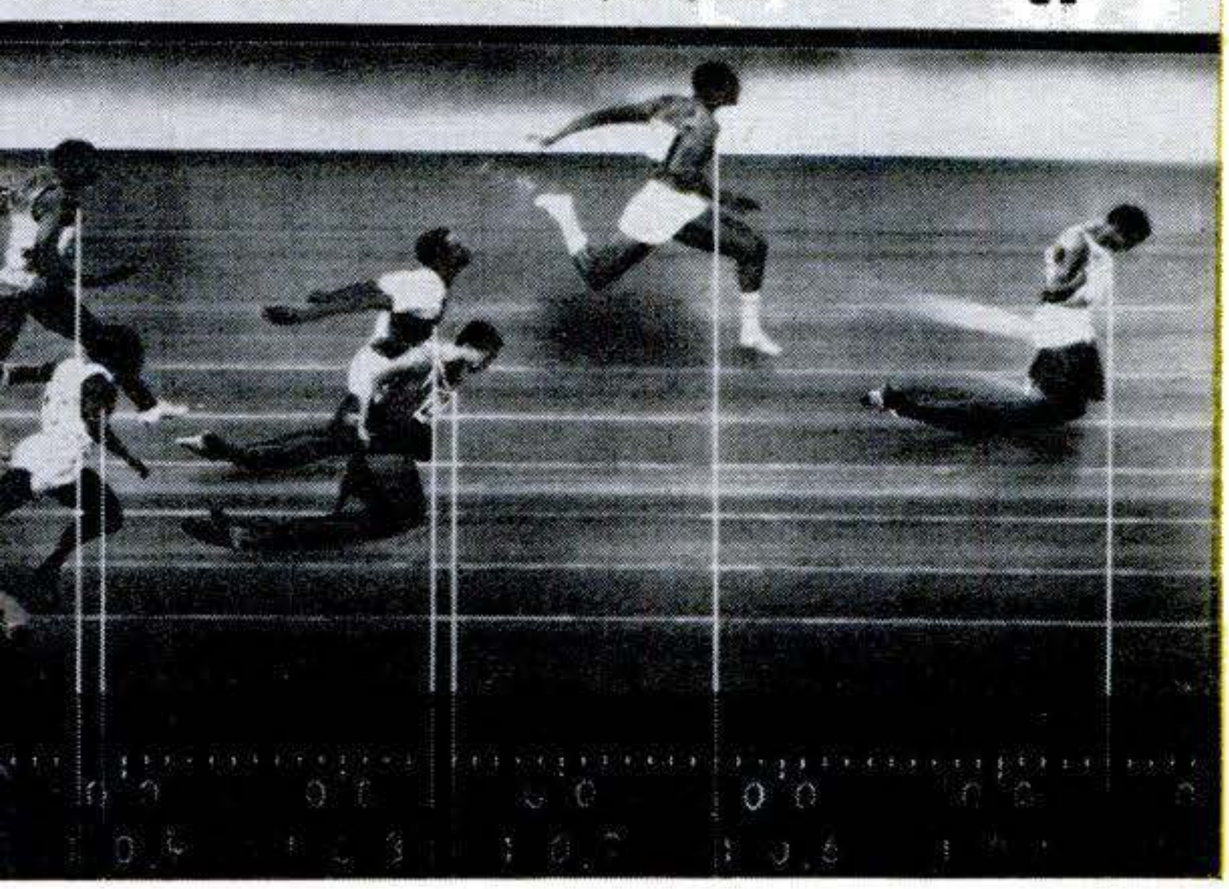
STARTER-PISTOL INPUT CONNECTOR



When the starting pistol is fired, a muzzle-mounted microphone (shown in drawing above) picks up the report, and sends a signal to the Photosprint's electronic circuitry that turns on the internal crystal-controlled timer.

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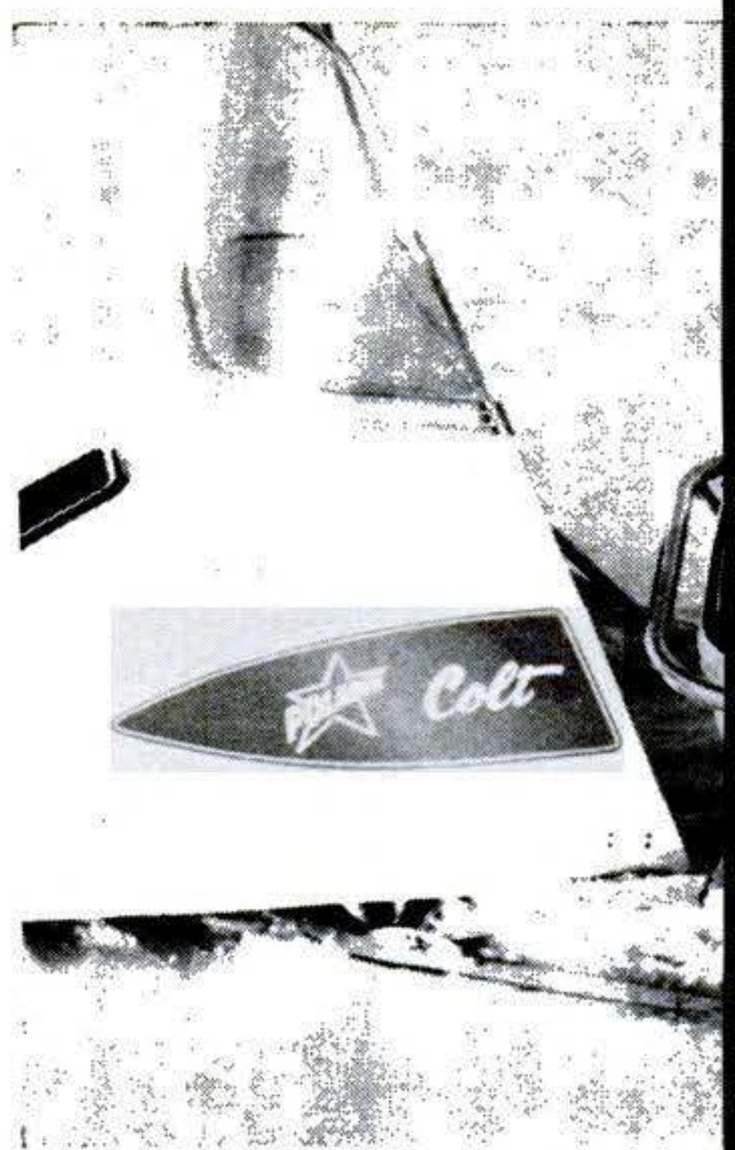
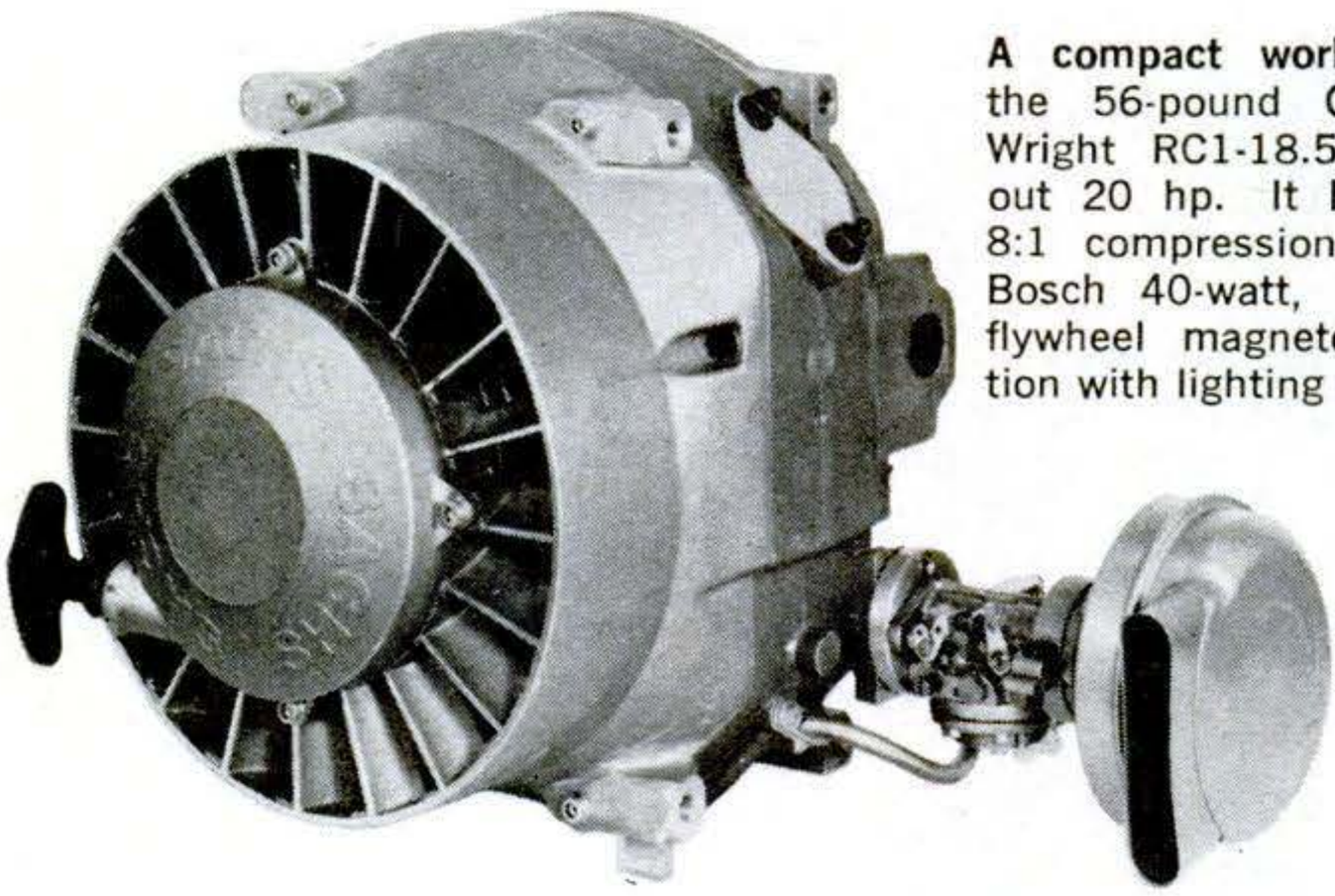
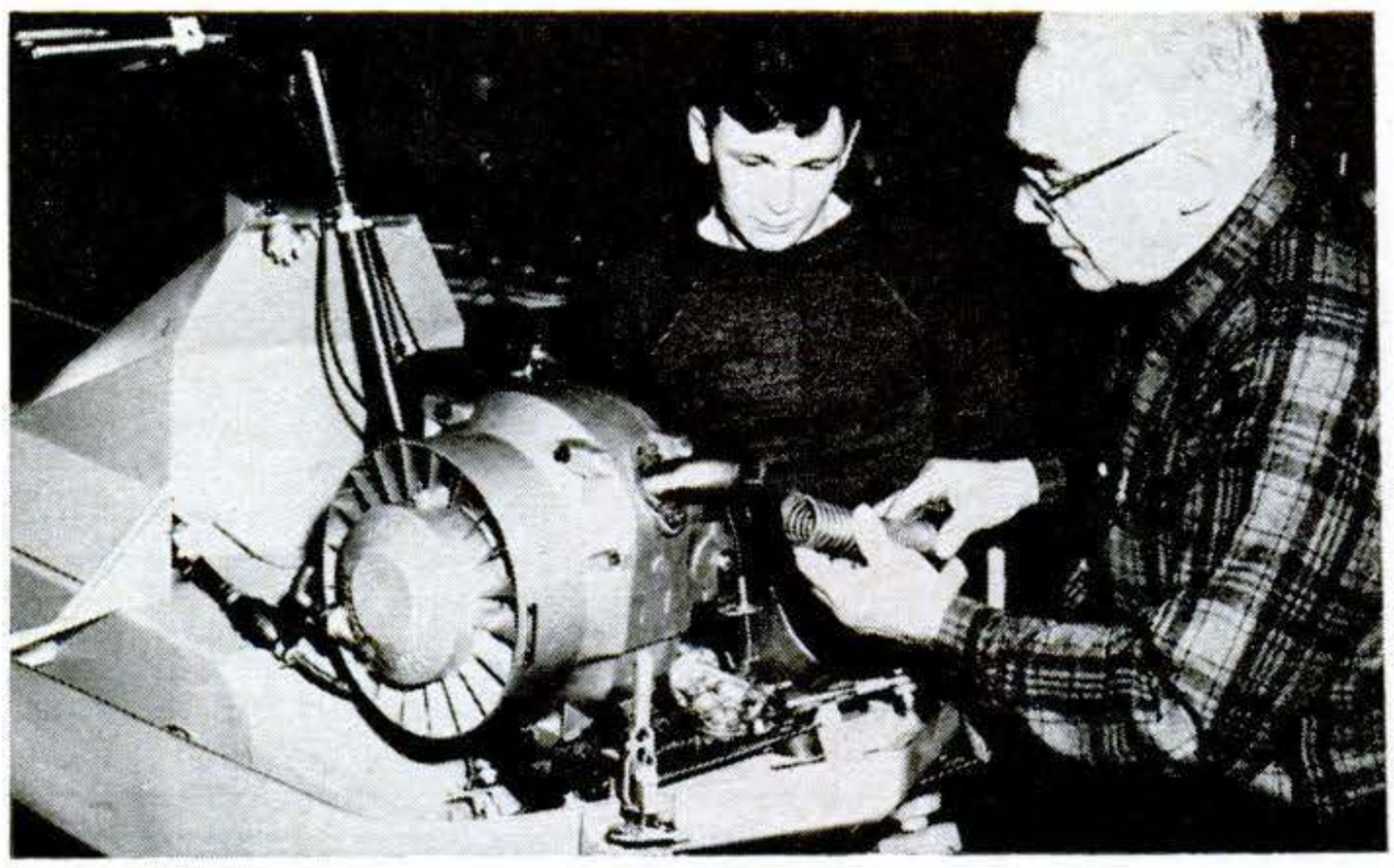
High-flying sport of snowmobiling has been given a shot in the arm with introduction of RCs in machines like this Trail-A-Sled Scorpion.



Pistonless RC in Polaris Colt pas with an A in rigorous two-year t



A compact workhorse, the 56-pound Curtiss-Wright RC1-18.5 turns out 20 hp. It has an 8:1 compression ratio; Bosch 40-watt, 12-volt flywheel magneto ignition with lighting coil.



Albin Erickson (right), chief of Polaris' research and development staff supervised two-year testing of the RC engine in snowmobiles.

RC engines—quiet, new power for snowmobile

If you're a hot fan of Wankel-type engines, one of the easiest ways to try one out is to get out in the cold on a snowmobile. Two Minnesota manufacturers – Polaris and Trail-A-Sled—have begun limited production of snowmobiles powered with rotating combustion engines.

Both companies are using the Curtiss-Wright RC1-18.5, an RC engine made in Germany by Fichtel & Sachs.

Polaris, after two years of testing, has installed the pistonless power plant in about 600 Colts and Mustangs.

Alan Hetteen, president of Polaris, says the Wankel-type engines start easier and run smoother than reciprocating engines. They're about half as noisy as the average snowmobile engine and operate so efficiently that there

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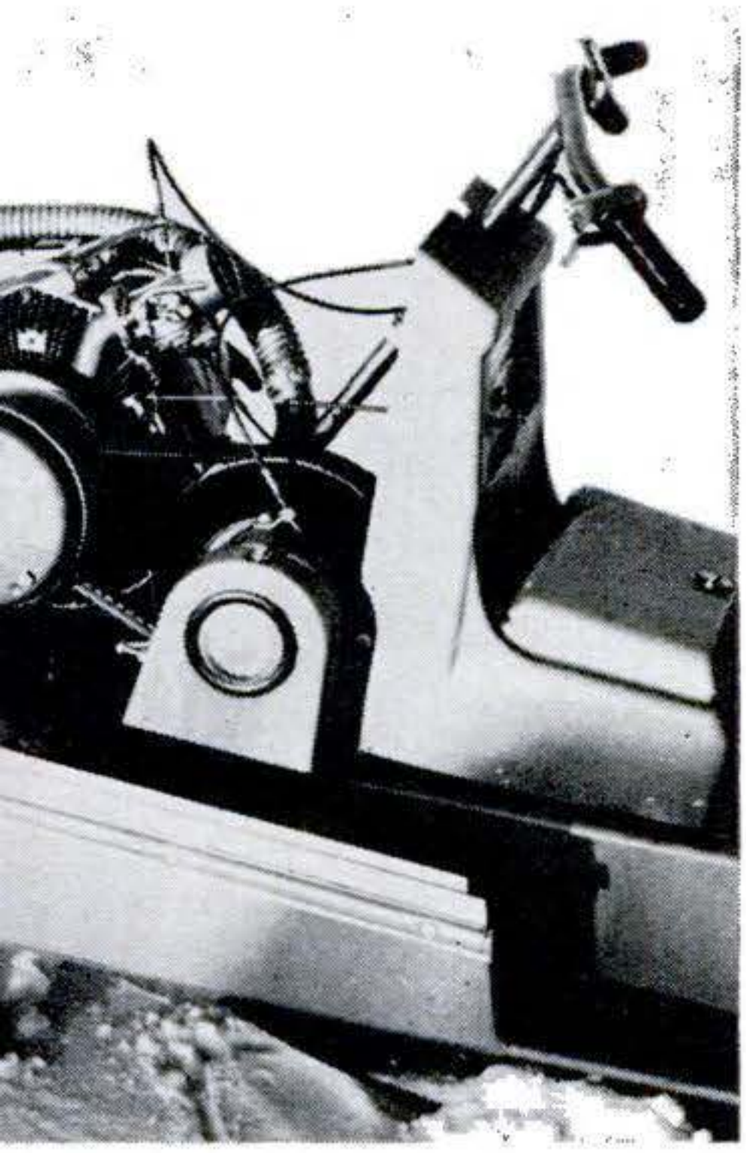


's now in production, made by chtel & Sachs, Germany.

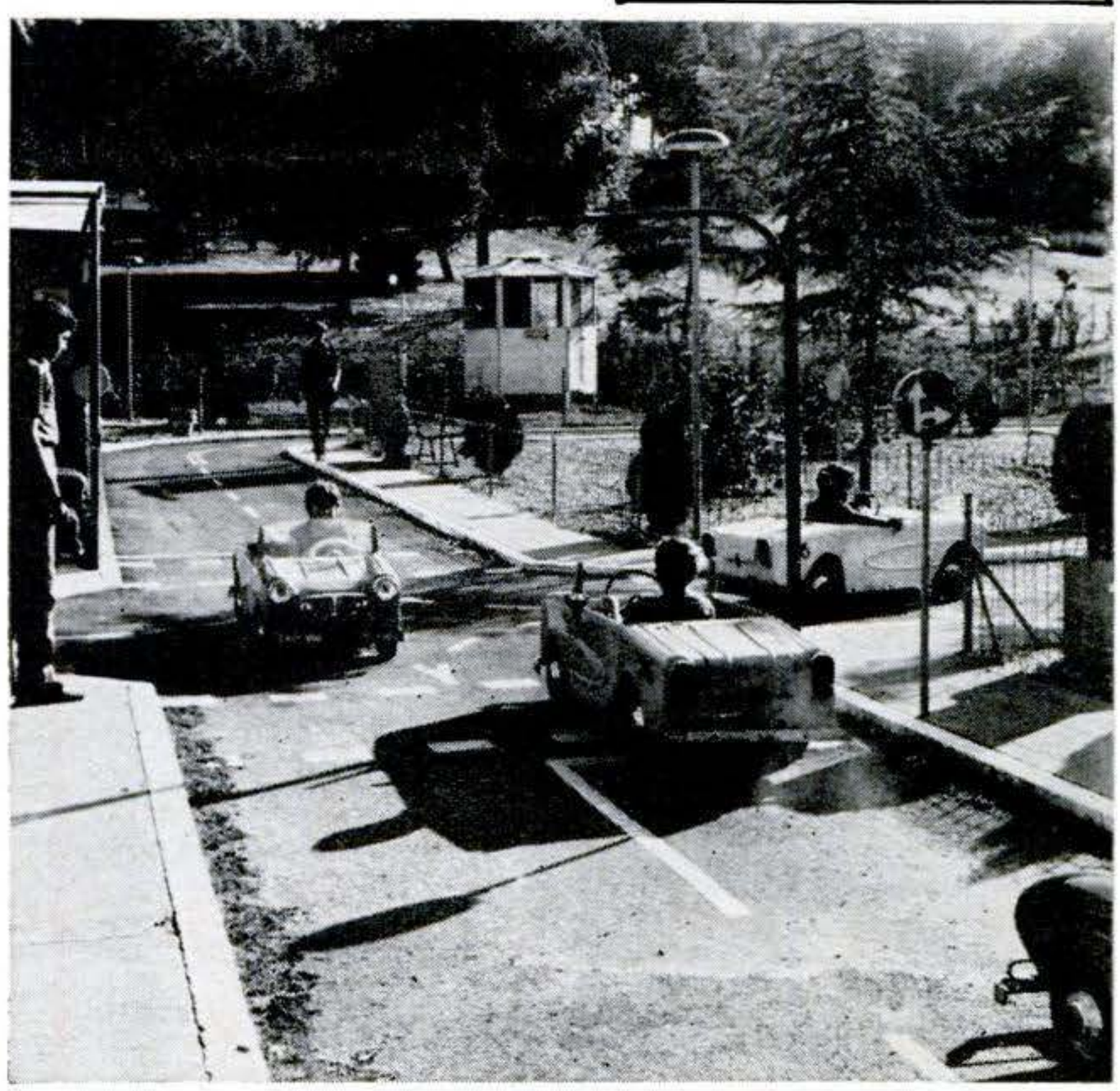
is practically no spark-plug fouling.

The RC1-18.5 turns out its 20 hp. at 5,000 r.p.m., has a displacement of 303 cc, and a compression ratio of 8:1. It weighs only 56 pounds, including its manual recoil starter, carburetor, and muffler.

Glenn E. Gutzman, Trail-A-Sled president, says their tests show that the RC engine burns up just about the same amount of gasoline as piston engines—maybe does slightly better—and they use a 40:1 fuel-oil ratio, compared with an average of 20:1 for standard snowmobile two-cycle engines. Further advantages, he says, are that quiet operation and ease of starting. He claims there's no loss in engine efficiency in cold weather, either.

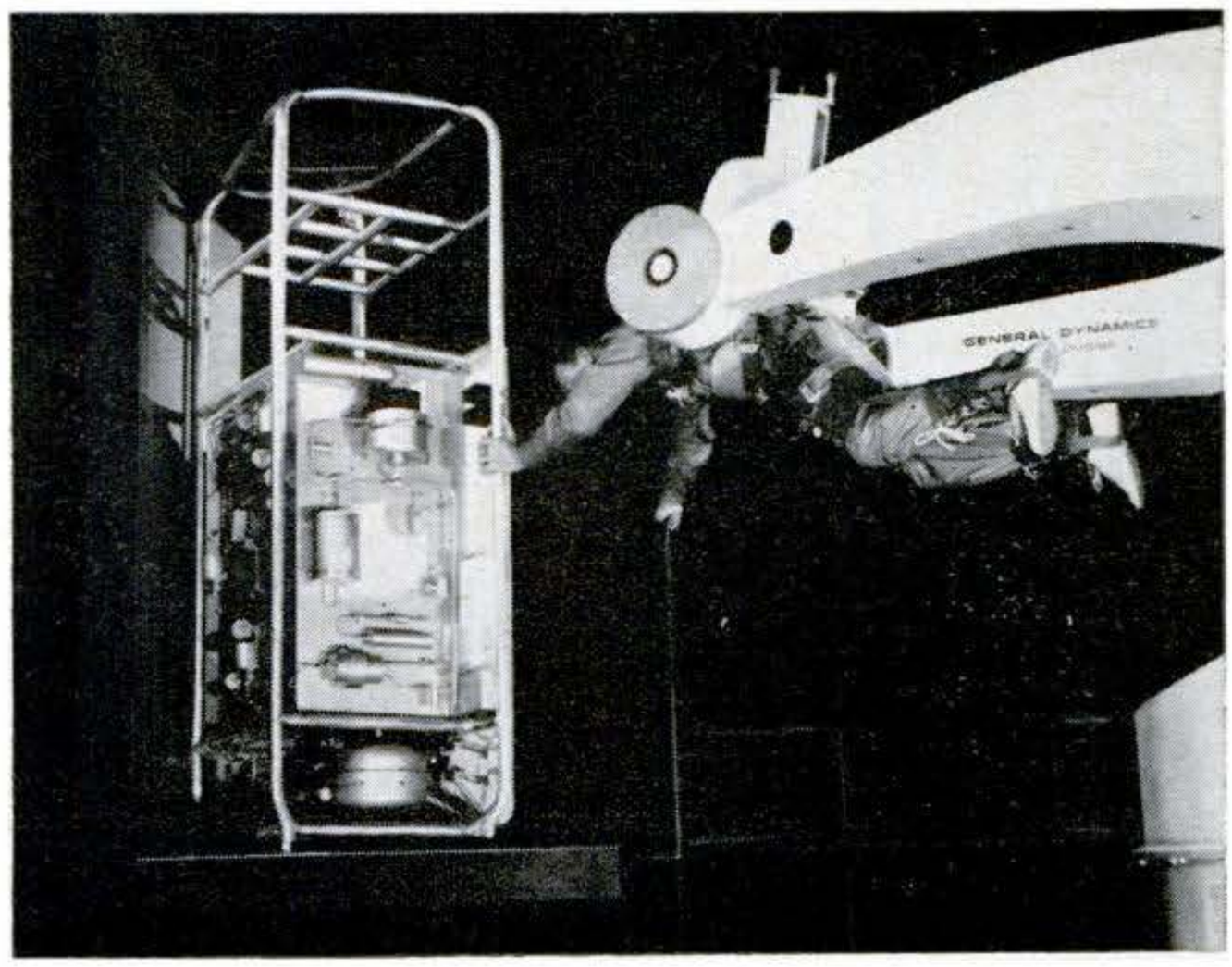
The RC1-18.5 is not designed for racing; it has low acceleration characteristics. But a special racing category has been established to permit RC-engined snowmobiles to compete in some events.

RC engines are off to a quiet start in snowmobiling, but they should be coming on fast in future seasons.



For traffic safety, teach the kids early

In Rome they begin instructing the kids early to drive safely. This public park has a complete street system in miniature. It's supplied with midget gasoline-driven cars. Children are encouraged to learn to drive with an eye to safety, both for themselves and other motorists. One basic lesson: Observe the signs.



Astronauts learn the mechanics of zero g

This astronaut, riding a six-degree-of-freedom (zero g) simulator, is learning to use a new swing-out cabinet developed at General Dynamics' Convair Division. The cabinet pivots out from the inside wall of spacecraft for easier removal of items. Astronaut grasps a bar (also in spacecraft) to prevent body movement.

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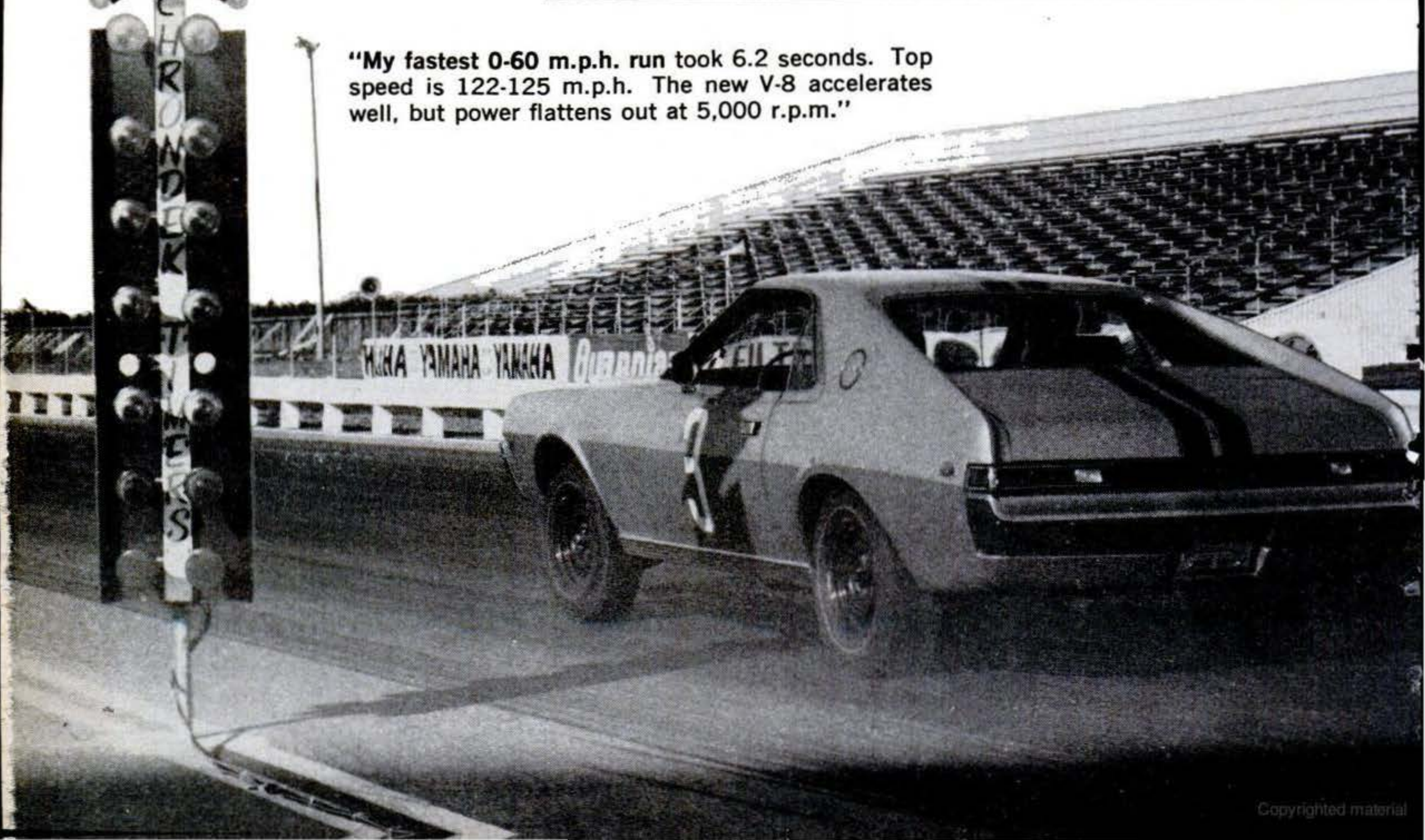
Mario Andretti Reports on the

Famous racing driver and twice USAC National Champion Mario Andretti tests American Motors' hottest car—"a fabulous package at $3,300"

PHOTOS BY JIM WRIGHT

"The AMX understeers (top) to the middle of the turn; then the front tires bite and the rear end breaks loose. I worked the brakes hard, but not to the point of fade. It did three panic stops (right) in quick succession without any problem."



"My fastest 0-60 m.p.h. run took 6.2 seconds. Top speed is 122-125 m.p.h. The new V-8 accelerates well, but power flattens out at 5,000 r.p.m."

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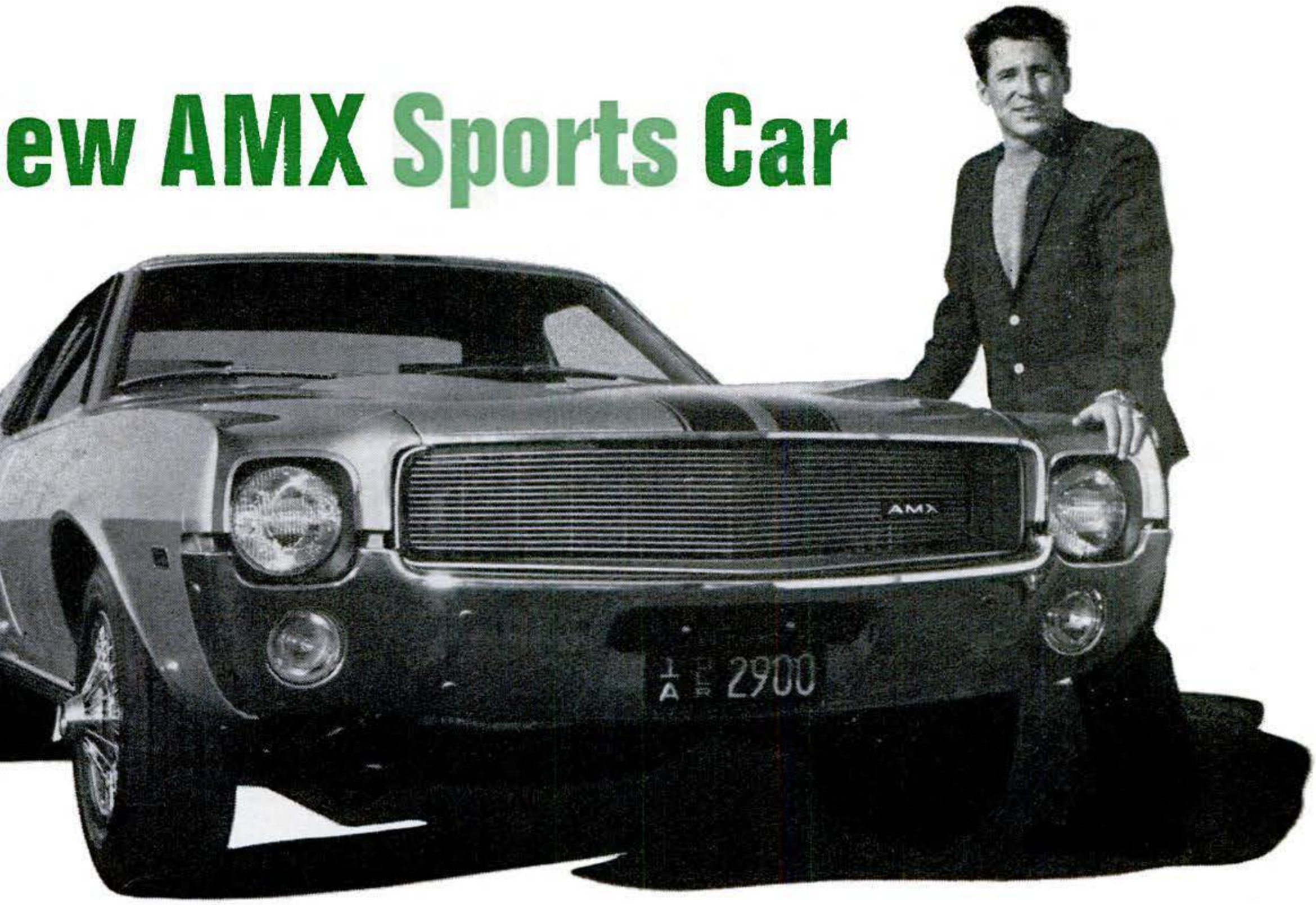
ew AMX Sports Car



"They did a real fine job of styling the AMX. Even with a high seat and ample head room inside that short body, the car has a long, low look. I call it both a smart and practical sports car."

I get a kick out of testing new cars. Cars are my business. To me, it's really great to drive the newest Detroit products before they are shown to the public. It makes a great change of pace from the pounding I take on the racing circuit, and it gives me a chance to keep up with what's new.

That's why I was happy to hear from Jim Dunne, POPULAR SCIENCE Detroit Editor, that American Motors' new AMX was ready for a test drive. We flew out to California, and I got my first look at this new sports car at Orange County Raceway, a combination dragstrip and road-racing course, just south of Los Angeles. We had a whole day to get to know the car and put it through all the tests we wanted. I'll give you the details later, but here are some clues:

- Acceleration is about what I expected.
- It has some handling peculiarities at high speeds.
- Passenger comfort is outstanding.
- Brakes stand up well, with constant, predictable action.

First I want to tell you something about the styling. It's a modern-looking, sleek two-seater. So maybe you don't expect much head room or well-padded seats. With its 97-inch wheelbase, you certainly wouldn't expect any useful space behind the seats. The truth is that the car isn't as low as it looks, and the interior is surprisingly roomy. It's even easy to get into and out of the AMX—no need for those contortionist exercises you sometimes go through with a small, imported sports car. The AMX is a completely practical automobile first, and a smart-looking package with all the appeal of a true sports car second.

Power? More than anything American Motors ever built before. After 0-60 in 6.2 seconds, you reach 80 in 11.5 seconds and 100 in about 16 seconds. Within half a minute, you've gone from standstill to top speed. I had to upshift early, because the test car was pulling a 3.54:1 axle, and the engine was running out of revs at 5,000. It is red-lined at 5,500, but valve float sets in below this. After 5,000, power falls off and all you get is noise.

Continued

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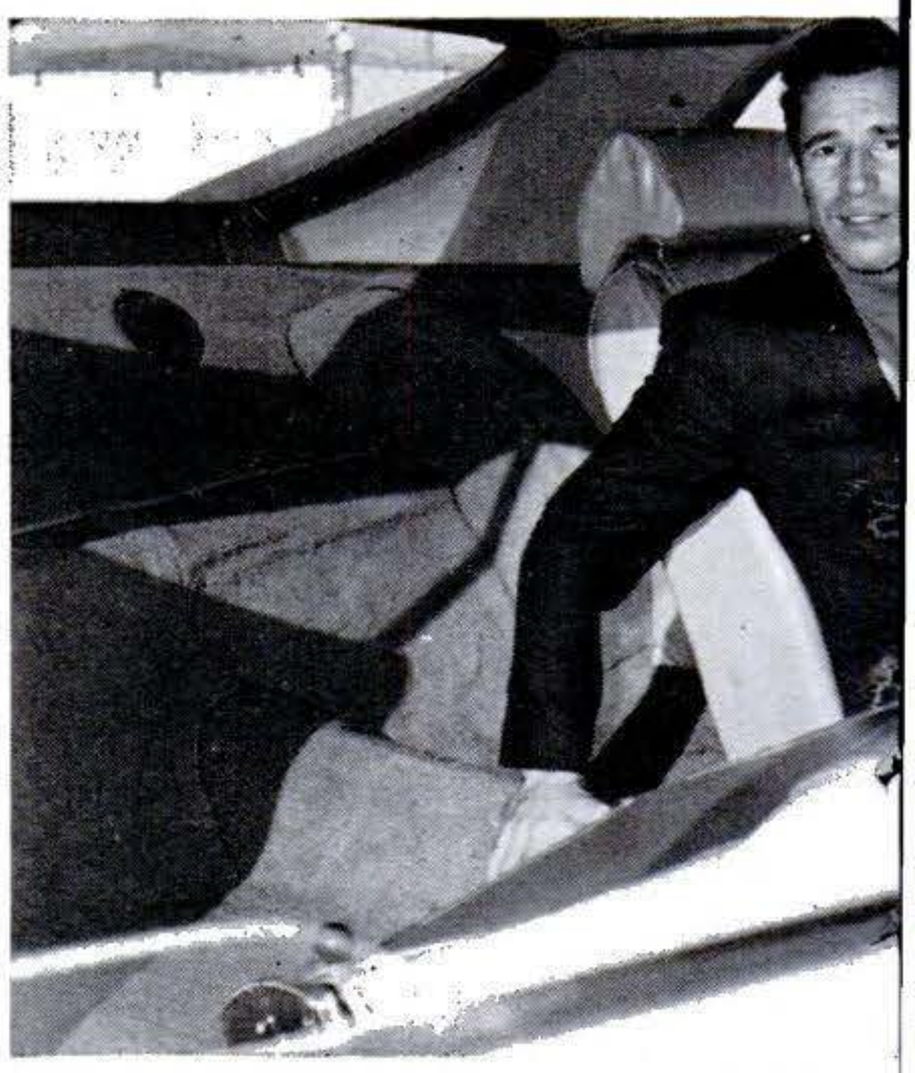
"**My AMX test car** had the new 390-cubic-inch V-8 engine that bangs out 315 horsepower at 4,600 r.p.m. I rate its performance on a par with other 390s I have driven—quick, but not shattering."

"**The steering wheel** is comfortably low in the lap and at a good angle. But I would have liked a more upright shift."



"**You could easily carry** a couple of kids, or your extra baggage behind the seats."

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The brakes were powerful and consistent. What's more, pedal travel was short. I found I could heel-and-toe with the brake and accelerator pedals to downshift under braking, just the way I do when I race. That's something few Detroit cars let you do.

I was less happy with the transmission. I don't think the ratios were very well chosen, either for road use or for racing. First, second, and third seem very close, and there's a big gap from third to top. Also, the shift bothered me. The stick is so slanted that to get into second I'm pushing down rather than pulling back. I'd like the stick more upright.

Handling. At all normal speeds, the handling is just fine. The car is front-heavy (66 percent of the weight is carried by the front wheels), and it has good directional stability. It's on high-speed turns that problems arise. You go into a curve and turn the wheel. The car responds, but not enough. You turn more. And more. Still not enough. So you back off the throttle to give the front tires a chance to bite. When they do, the rear wheels lose traction and the tail starts to swing out. You end up countersteering, with wheels pointing right on a left-hand turn. Another high-speed phenomenon: The side windows push away from the roof railing when the fresh air coming in the vents builds up too much pressure inside the car. This, by the way, only happens above 110.

Ride comfort in the AMX is in the Mustang/Camaro class despite an 11-inch-shorter wheelbase. Over undulating roads, the whole car rides up and down in a bouncing motion instead of spanning them with alternating dives and takeoffs like a porpoise, the way some longer cars do. For most driving, I'd recommend power steering. You get the quick 18:1 steering ratio, which makes the car much more pleasant around town. If you insist on manual, you get a slow 24:1.

I liked the no-chrome interior. The cockpit seems very businesslike and suits the character of the car. Seats are comfortable, with tilting backrests.

They told me the car would sell for about $3,300, and at that price it's a fabulous package: hot performance, safe brakes, great ride comfort, sports-car size, and smart looks. PS

"Trunk is short but very deep. It will hold two good-size suitcases, with some juggling around."

"Backing up is tricky because the car is much shorter than it seems when you're at the wheel."

Facts on the AMX

DIMENSIONS (inches)	
Wheelbase	97
Front track	58.6
Rear track	57
Length	177.2
Width	71.6
Height	51.7
ENGINE	
Type	OHV V-8
Displacement	390 cu. in.
Bore & stroke	4.17 x 3.57 in.
Compression ratio	10.2:1
Carburetion	Carter 4-bbl.
Valve lifters	Hydraulic
Power @ r.p.m.	315 @ 4,600
Torque @ r.p.m.	425 @ 3,200
CHASSIS	
Transmission	4-speed Warner, all-synchromesh
Axle ratio	3.54:1
Tires	Goodyear E70-14
Brakes	Bendix disk/drum
Steering	Power-assisted
Steering ratio (overall)	18.1:1
Turns, lock to lock	3.8
Turning diameter	33.5 ft.
Curb weight	3,185 lb.

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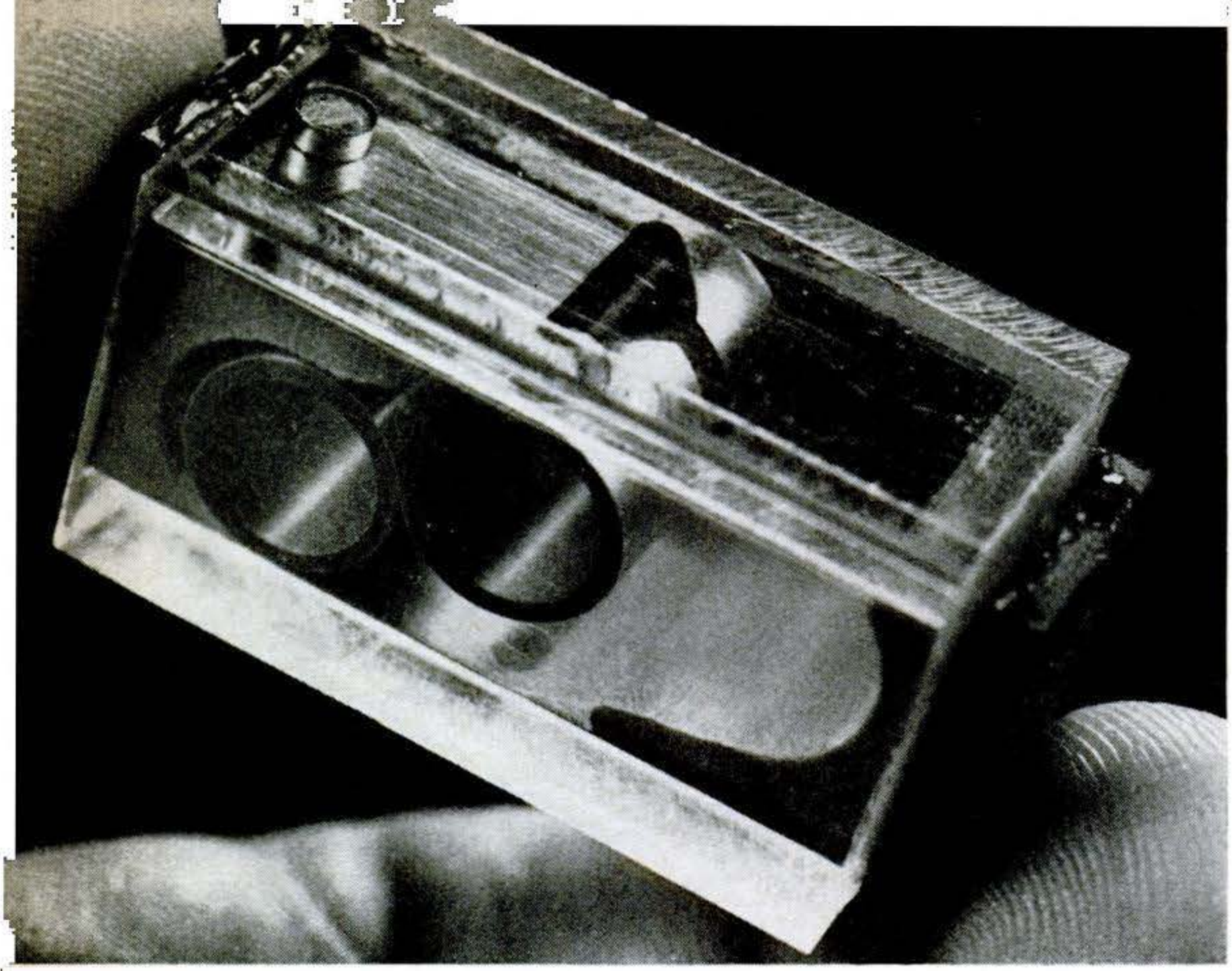


As basic as the lever or the pulley, the simple concept called "rolamite" promises a revolution in mechanical design

By HARRY WALTON

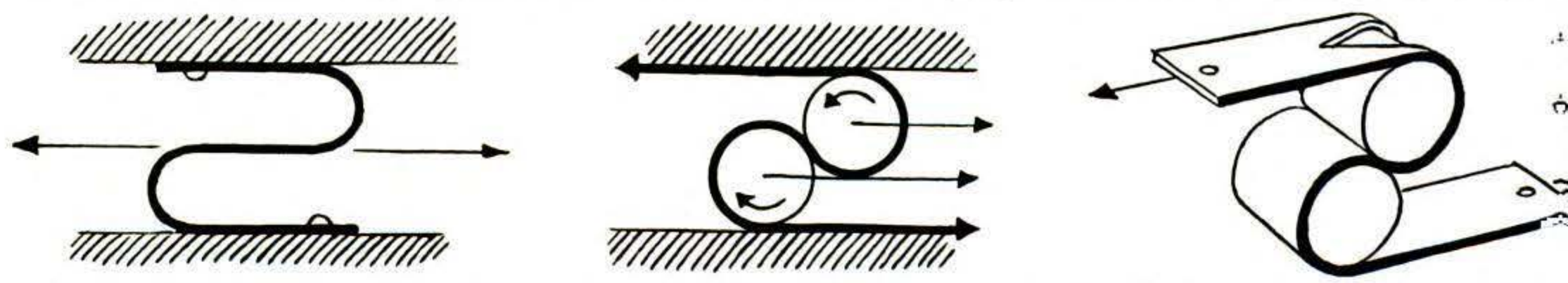
Designed to cut off rocket engine, roller cluster in this rolamite gravity switch snaps to right when certain *g* force is reached. Exact value is set by the size and shape of cutout in the band (visible at top).

"Frictionless" Machines from Rollers and Bands

What's a rolamite? It looks like a simple gadget made with two rollers and a steel band, but it's much more. As basic as the wheel, the lever, or the hinge, it is the only elementary machine discovered this century. Its use will be widespread—in everything from switches, thermostats, and valves to pumps and clutches, and as almost frictionless bearings.

The rolamite concept is the invention of Donald F. Wilkes, a Sandia Corp. engineer who was studying a suspension system made with a bent elastic band fastened to opposing surfaces in an S shape. He found that the center of the loop could be moved horizontally with amazingly little resistance. (To try it, clamp one end of a steel tape to a table and another section to a ruler held horizontally above it.)

But the band can provide no positive mechanical action. In a flash of genius, Wilkes inserted two rollers, large enough to overlap and so key themselves in, and the rolamite principle was born. The rollers may move in a fixed frame or one of the horizontal frame members may move on the rollers, travel being limited by the length of the band.



Basic rolamite uses a flexible band of steel or other material curled in an S shape and forming a freely moving loop. Two rollers are then inserted and the band is put under tension. Roller cluster now moves along band with amazingly little friction. By making cuts in band, roller action can be that of a

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As the rollers are pushed to the right, for example, they turn in opposite directions, but are always in rolling contact with the band. Nothing slides, rubs, or slips; it is always the same points that come into contact between roller and band. And a rolamite unit never needs lubrication.

Prepackaged energy. What about band-flexing? It would seem that takes energy, creating friction. But that energy is prepackaged when the band is installed under tension. Bending of one part of the band is accompanied by the straightening of another, which supplies the needed energy.

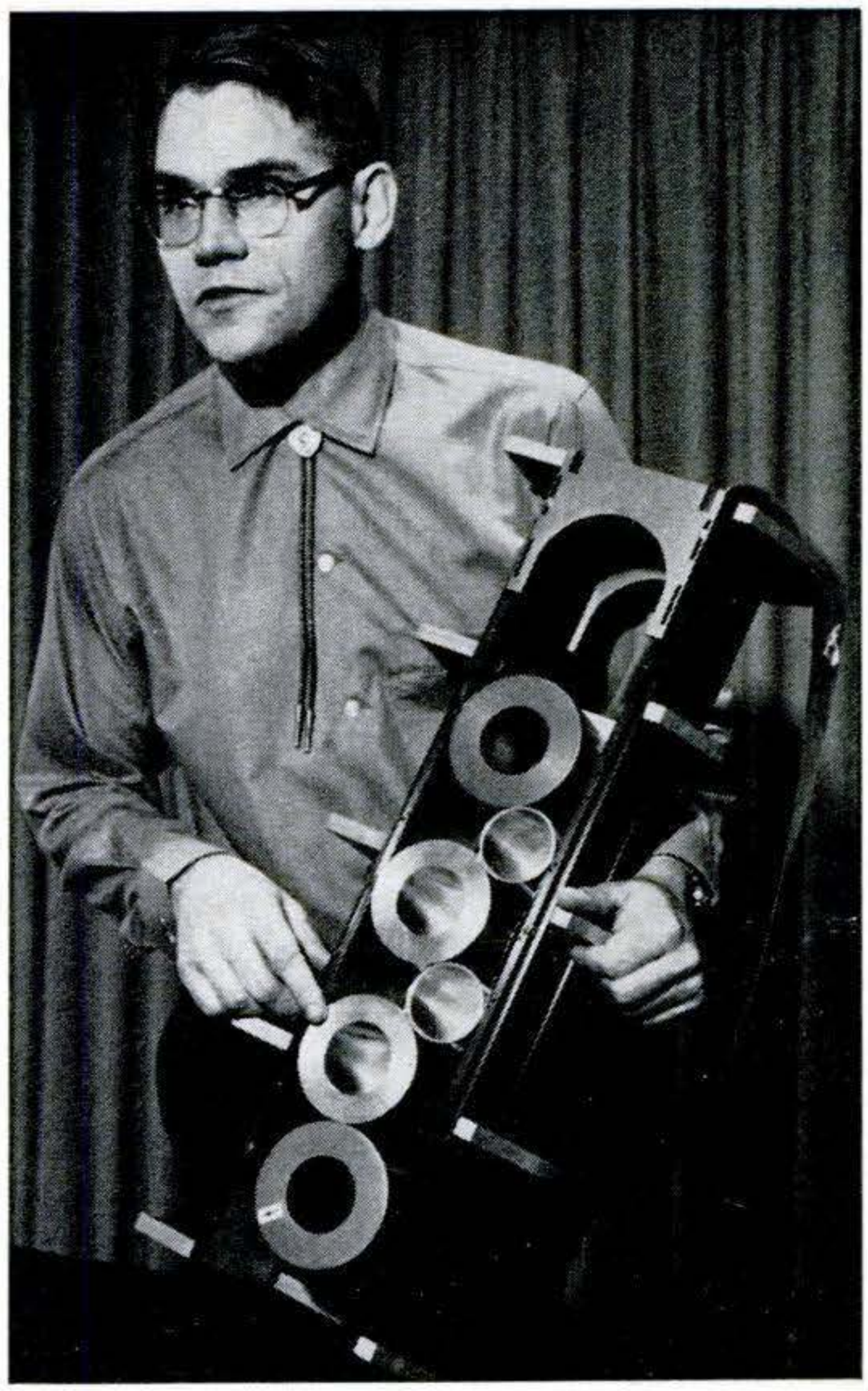
In tests, rolamite devices display friction of an amazingly low order—one to 10 percent of that in the best ball and roller bearings of similar capacity.

The rolamite units closest to production are designed for light loads and such jobs as opening and closing contacts or valves or performing mechanical operations. A rolling frame member might carry control studs, fluidic valves, or printed-circuit contacts on its outer surface.

Tricks with bands and rollers. Instead of being uniform, bands can introduce more or less resistance at some point of roller travel. Holes of various shapes can be punched in them to make action easier at a predetermined point and to a precise degree. Bimetallic elements and springs, even cloth, plastic, or rubber bands can be used.

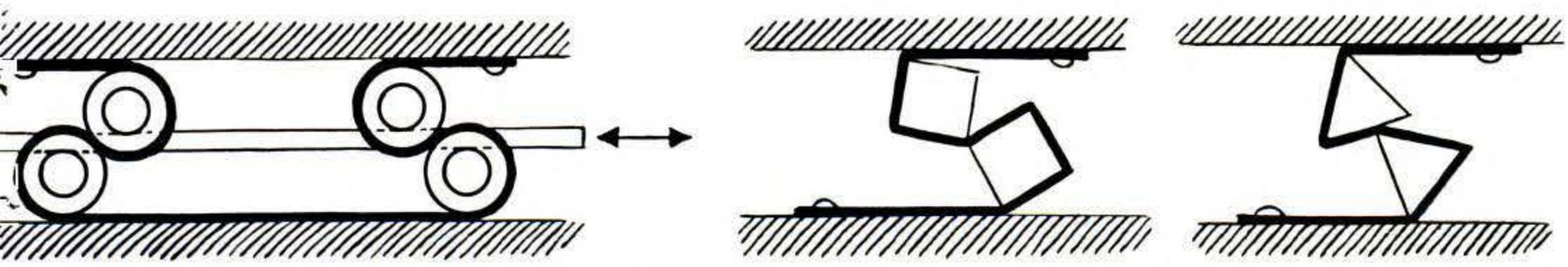
Such modifications can produce a snap action, sudden braking, latching, and other control functions. A sharply bent band can act as a detent.

Rollers can be fitted with bulges or rubber stops for positive braking. The rollers can be of different sizes. If one is smaller, it turns faster than the other and you have a speed-changing device. Extra rollers may be added, always two at a time. They may be spool-shaped with a moving table between them. Even square and triangular rollers are possible.



Inventor Donald F. Wilkes displays a multiroller demonstration rolamite. Unlike ball bearings, rolamites approach "pure rolling state." There is no rubbing, skewing, or slipping, and no oil is needed.

Fascinated by the possibilities, Wilkes and other Sandia people have doodled up rolamite light switches, fishing reels, vibrationless sanders, clutches, a greatly improved toilet valve, an odometer, a reciprocating variable-speed tool drive, and even a pellet-shooting toy gun. There's no end in sight.



snap-action switch, a thermostat (when a bimetallic band is used), or any of at least 50 other devices. Rollers can be any shape. Four spool rollers can support a traveling table, for example. Square and triangular rollers (above) are even possible and lend themselves to certain control functions.

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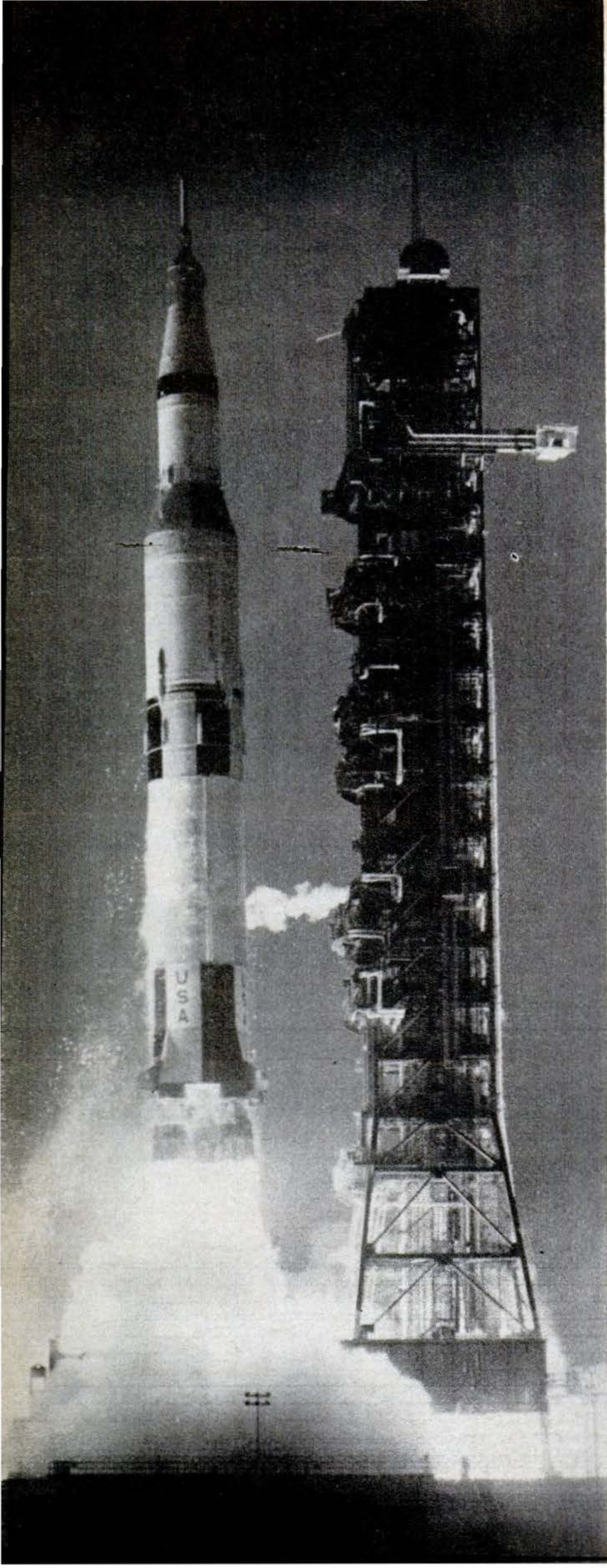

Bigges

By DR. WERNHER VON BRAUN

Director of NASA's George C. Marshall Space Flight Center, Huntsville, Ala.

The leader of the Saturn team reveals the story behind the success of our first Saturn V-Apollo—an "all-up" gamble that won, to short-cut the way to a manned lunar landing

Within a few weeks our second Saturn V rocket is due to put an Apoll spacecraft through new flight tests. Following the unmanned trial will come a least two manned Apollo flights thi year, including Saturn V's first man carrying mission.

What has cleared the way and i speeding these plans is the striking suc cess of the Apollo 4 mission—the maide flight of our giant Saturn V rocket.

The first Saturn V, with the fourt Apollo spacecraft in its nose, roared o its launch pad at NASA's Kenned Space Center at seven a.m. last Novem ber 9. Eight hours and 41 minutes late the Apollo Command Module gentl parachuted into the Pacific in sight o its recovery ship, the carrier USS Ben nington—its heat shield having passe the fiery test of a 25,000-m.p.h. reentr simulating a return from the moon.

It was the most difficult mission eve attempted in our space program—i terms of size, power, weight, cost, lack c precedent. Some news commentato

Up goes Saturn V, with Apollo spacecraft in nos on its spectacularly successful maiden flight. Giar 364-foot-high rocket—the crowning achievement c Dr. von Braun and his Saturn team, though his art cle modestly omits due credit to him—demonstrate its might by thrusting 140 tons into earth orbi

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Rocket's Flawless Flight Speeds Moon Plans

even called it the most ambitious technological task ever undertaken by man.

Mission went perfectly. From telemetered data, there seemed at first to have been minor hitches—a second-stage engine quitting prematurely, a balky third-stage vent valve. Now we know these were false alarms, from gauges that played no active part in the mission. The flight was flawless.

Its success was a personal triumph for NASA's Associate Administrator for Manned Space Flight, Dr. George E. Mueller. It was he who, in the face of a more cautious and conservative attitude on the part of his closest associates (including myself), staunchly upheld the "all-up" testing concept. That meant trying out all three stages of Saturn V at once—and the Apollo spacecraft, too.

Customarily, flight-testing a new space vehicle begins with mockup hardware instead of live upper stages and a live spacecraft—and ultimate missions come only after success with simpler ones. True, the all-up concept has been tried for some military missile systems. But even the most complex, the Minuteman, was a humble firecracker compared with Saturn V-Apollo. Except for a Lunar Module, which was simulated, the Apollo 4 flight carried everything required for a manned flight to the moon.

What was the reason for Apollo 4's complete success? It would be unmindful of Providence for me to say that "a little bit of luck" had nothing to do with it. And apparently we had very competent contractors. But you cannot rely on luck or contractors' competence alone in dealing with hundreds of thousands of parts, thousands of vendors, hundreds of subcontractors, and 20-odd prime contractors for flight hardware and vital ground-support items.

The scheme behind Apollo 4's success. Only one out of 20 men working on the Apollo program is on the NASA payroll, but overall responsibility clearly rests with NASA. Having established a sound concept of how to go to the moon, and defined the program's needs, NASA had to set up a system of management and program review to see that hardware items would work, that the taxpayer got his money's worth, and that efforts went according to schedule and master plan.

On the Washington level the Apollo program is directed by Maj. Gen. Samuel C. Phillips, an Air Force officer on temporary assignment to NASA with an impressive record as manager of complex new weapons systems. An Apollo Program

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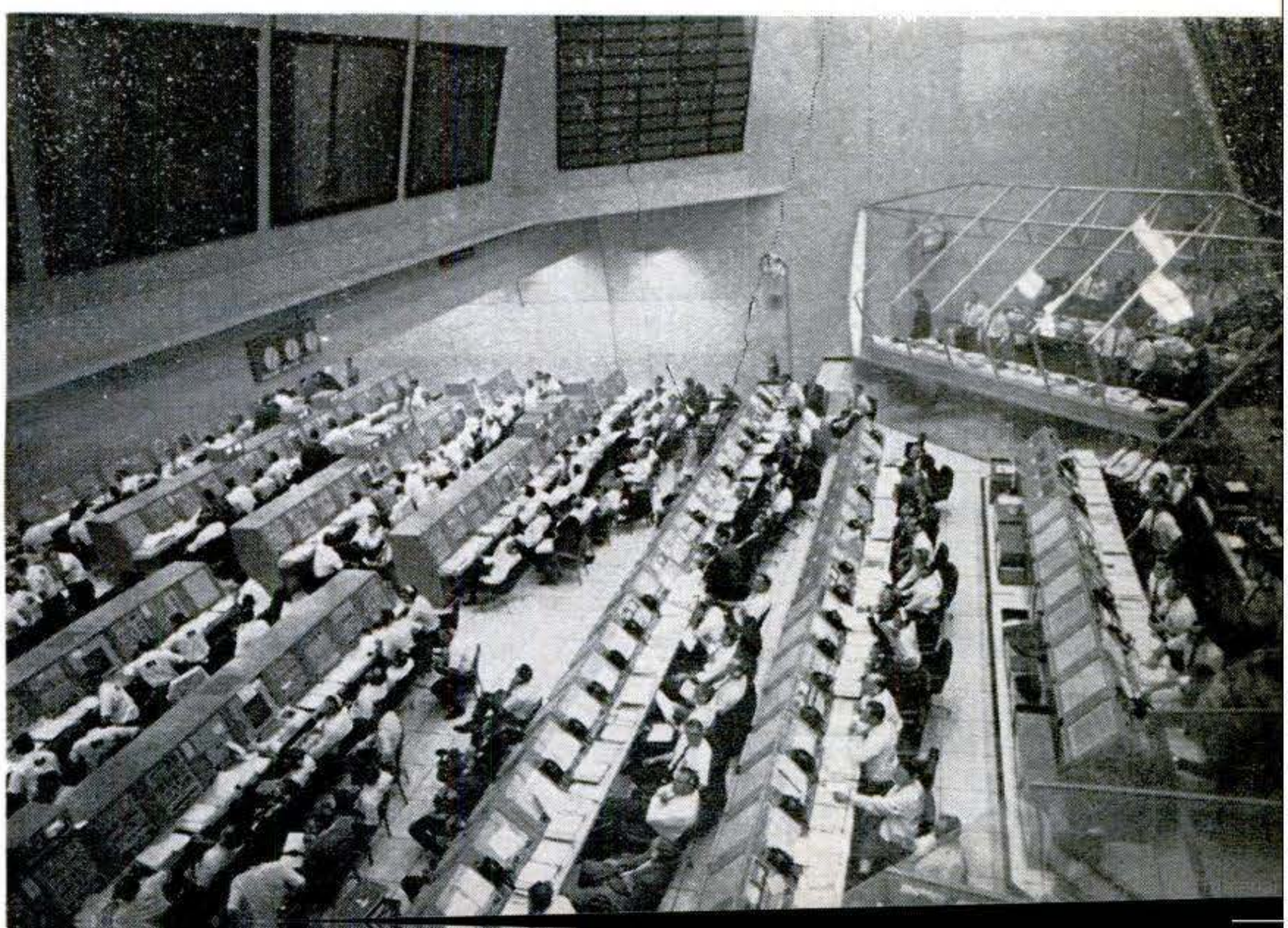


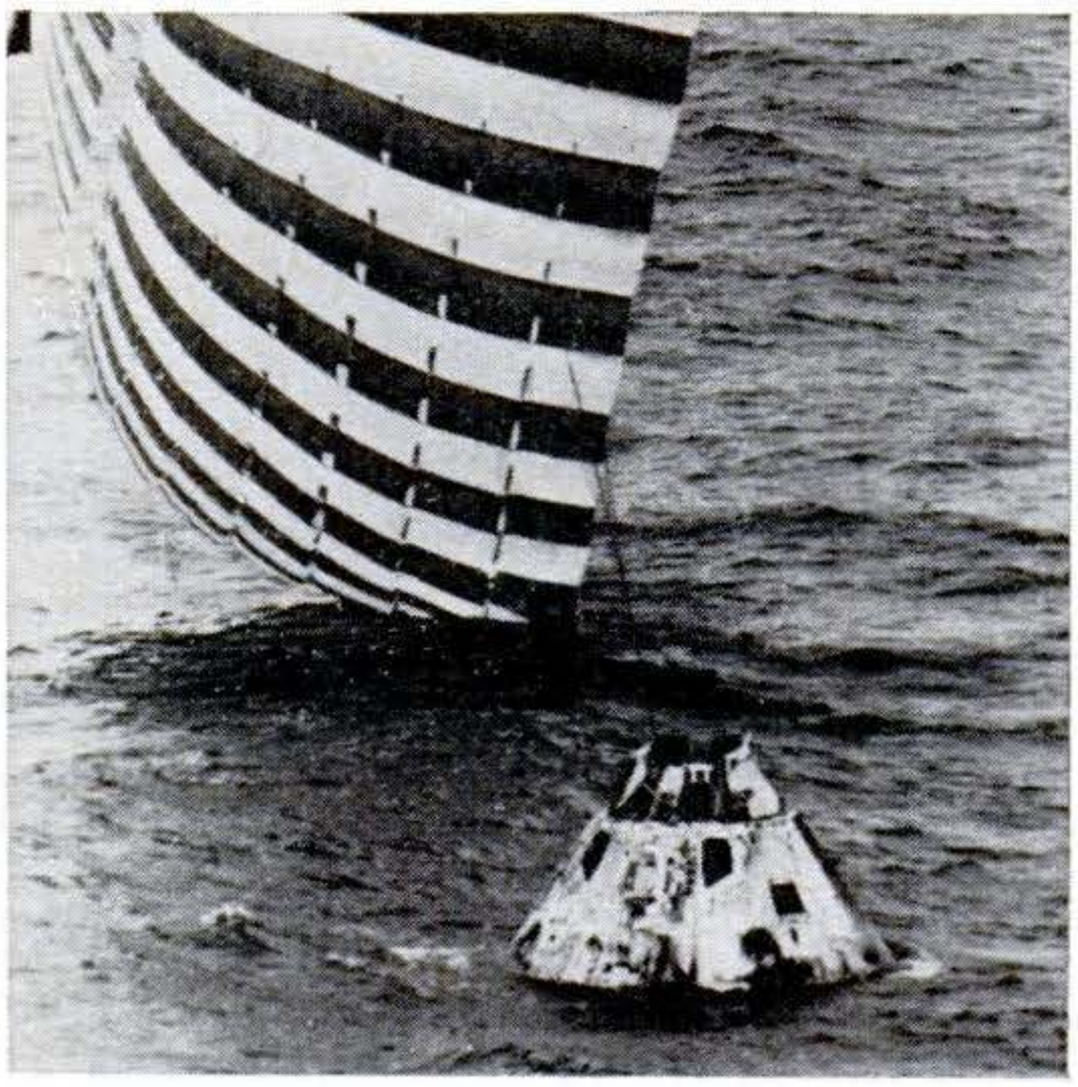
Launching Saturn V took this array of men and equipment, pictured during actual countdown, in firing room 3½ miles from pad. Lift-off was exactly one second behind prescheduled launch time.

Earth looked like this to camera in Apollo spacecraft as it climbed from Saturn V orbit to 11,000-mile height, for start of power dive to test heat shield in fiery reentry at 25,000-m.p.h. speed of a return from moon.

Office at each of the three Manned Space Flight Centers—at Houston for the Apollo spacecraft, at Huntsville for the Saturn vehicle, at Cape Kennedy for launch operations—receives from Gen. Phillips its directives, guidelines, and resources. In the last five years these program offices, ably supported by the centers' research scientists and development engineers, burned tons of midnight oil over the program's endless details.

In monthly reviews before the Manned Space Flight Management Council—made up of Dr. Mueller, his two deputies, and the three Manned Space Flight Center directors—the Apollo Program Director and Program Offices in the field present accurate accounts on the status of money, manpower, timetables, critical items, and necessary changes. The reviews eye these areas, particularly:

Components. Every item—a structural part, a valve, a relay—has to prove able to withstand its predicted environment: high or low temperature, violent vibrations, or ambient vacuum in outer space.



In flight's bull's-eye finish, Apollo plops into sea in sight of recovery ship 275 miles off Midway Island. It passed heat-shield test, and all its contents—including its earth-photo film—were found intact.

Systems. Parts must work as a team. A space vehicle placing a spacecraft off a ship's bow in the far Pacific can be compared to a postman delivering a package. An instruction is placed in a memory—the postman's, or that of Apollo's guidance computer. Energy is expended—by the postman's leg muscles or Saturn V's engines. In between, a complex network's functions are vital to success. Like a postman, Saturn V needs a sense of balance (its autopilot) and a muscle-controlling nervous system (its electric network) to get where it is going.

Tests of systems, therefore, complement tests of components. And a study showing a system at the mercy of a single part's failure may lead to a design change or provision of back-up elements.

Manufacture. Testing finished items is not enough. Inspection during their manufacture avoids painful discoveries too late, when rejecting a costly product is the only recourse. Continuous monitoring of makers' processes played a major part in the success of Apollo 4.

Engineering changes. Tests produce directives to makers to rectify deficiencies. Meanwhile, components arriving at assembly plants may lack the changes. Lest chaos result, the answer to keeping track of innumerable alterations has been found in "configuration control," using a multi-layered Change Board and a document-policing organization made up of both NASA and contractor personnel.

Thus, building a craft to carry men to the moon—challenging as it is to engineers and scientists—exhibits broad management aspects having little to do with engineering and even less with science.

One of the best criteria of a competent management system is that it carefully follows up on every single action taken to make sure nothing has fallen through a crack. The success of Apollo 4 showed that nothing had.

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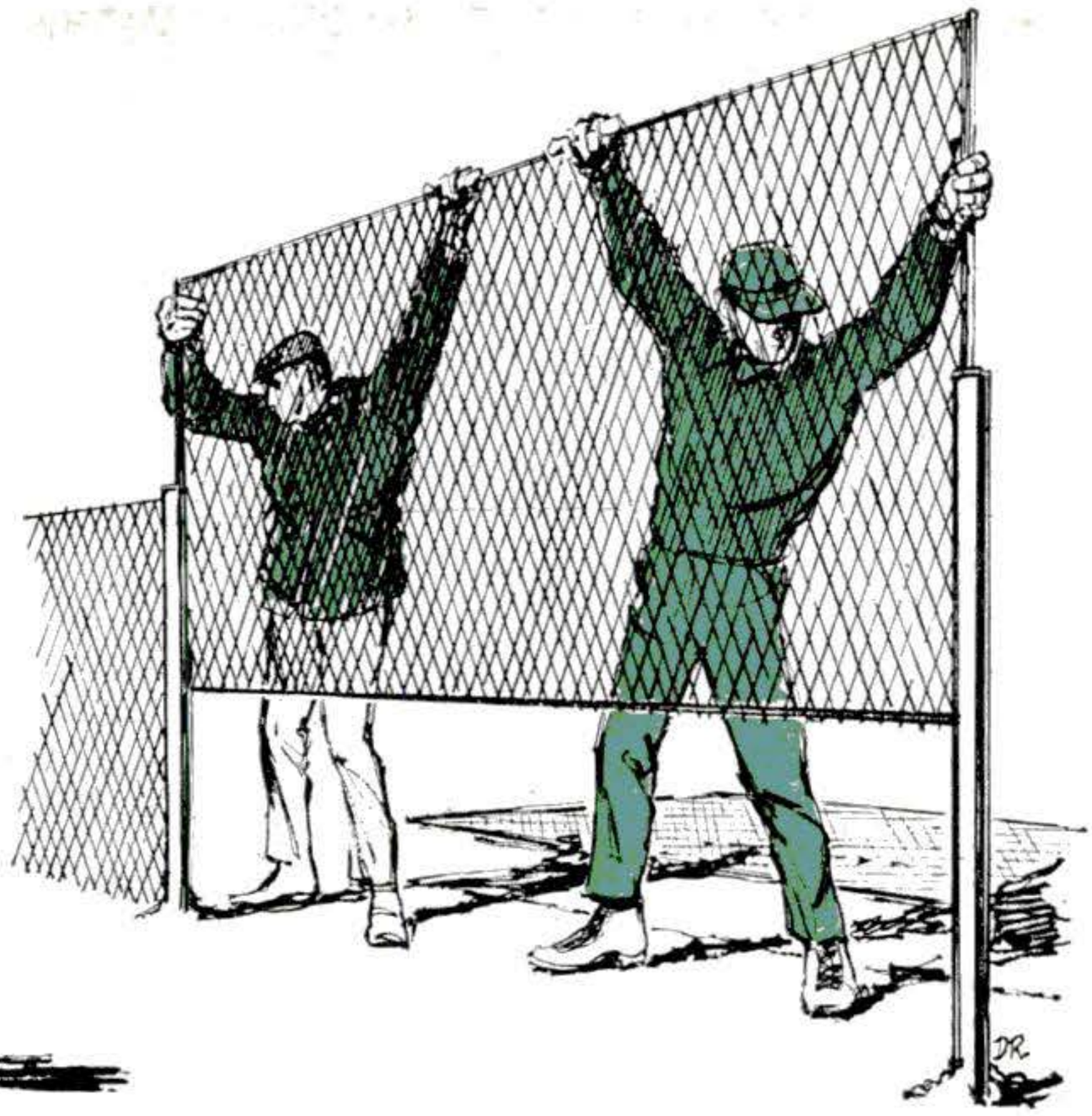
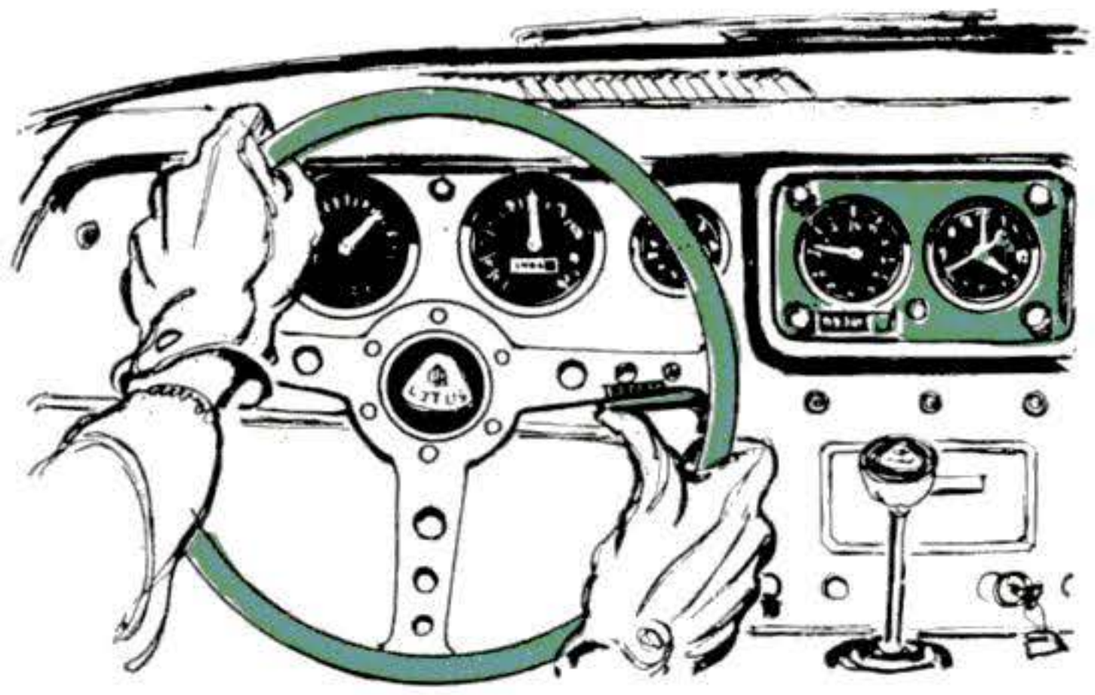
"I'd like to see them make..."

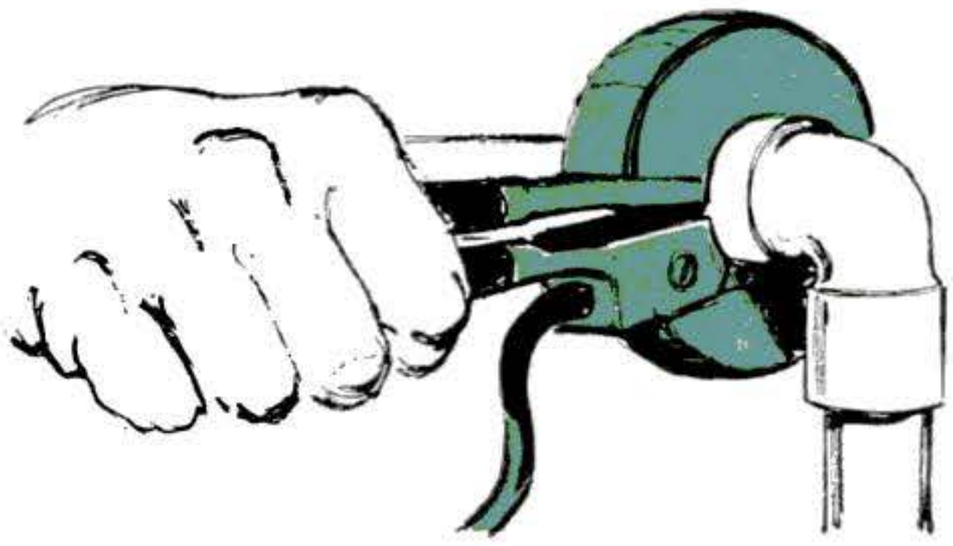
DRAWINGS BY DANA RASMUSSEN



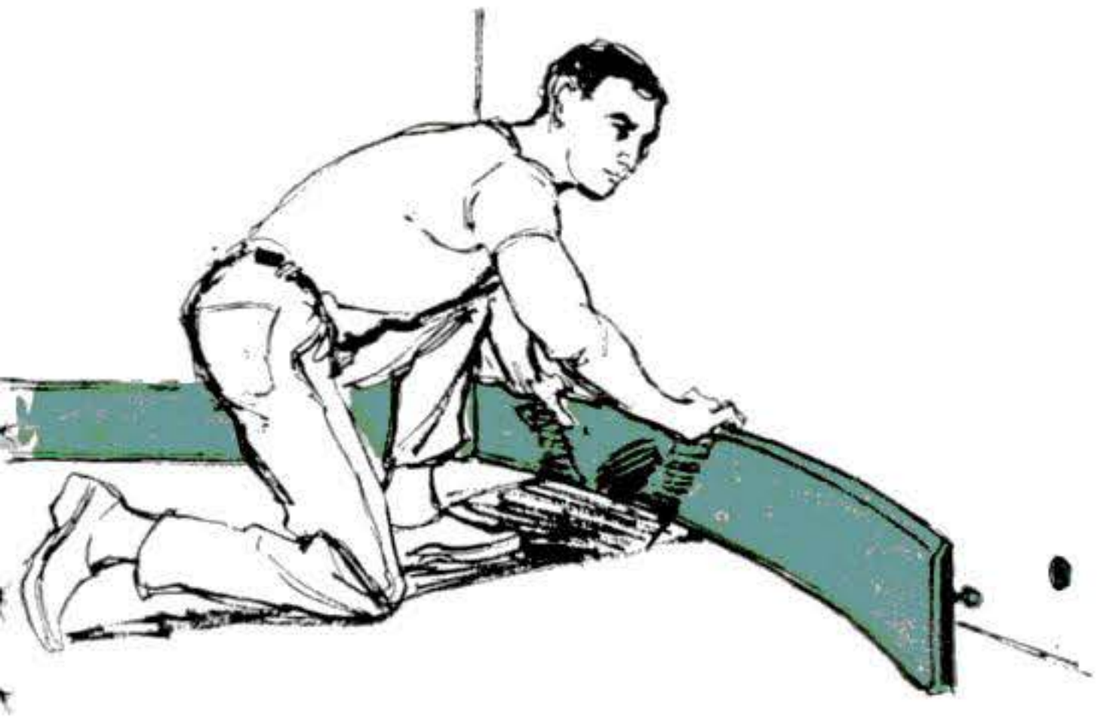
Slide-in fence sections that would drop into the posts. You could lift them to mow, or to paint them standing erect. – *David Jackson, Bradford, Ark.*



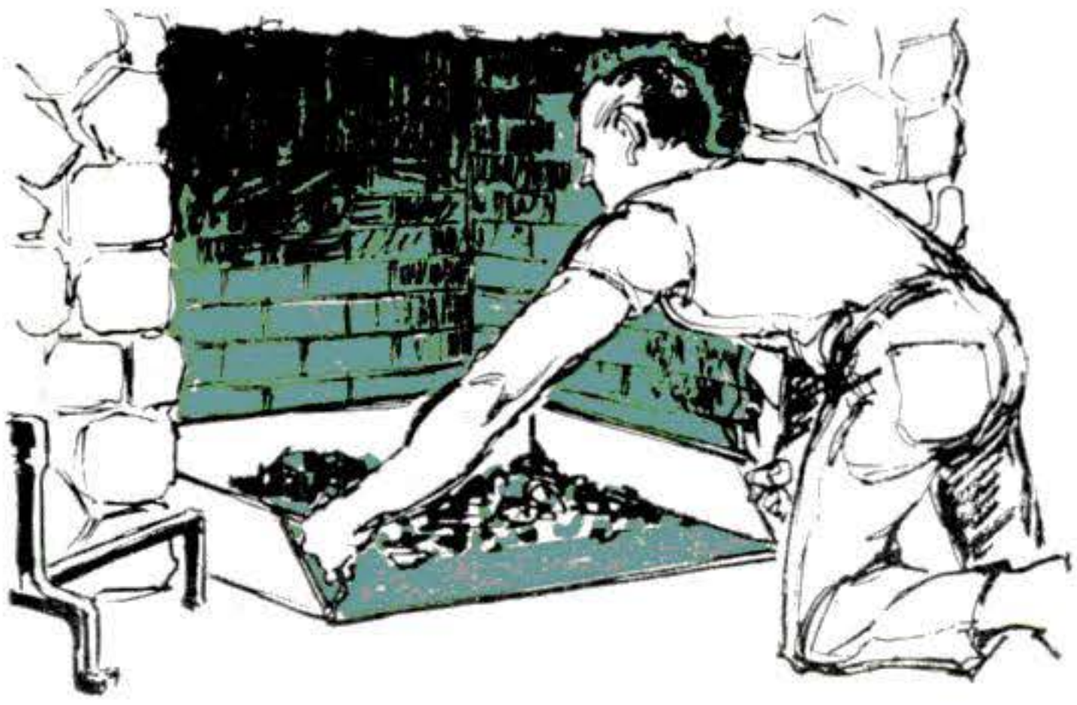
Driver-controlled stopwatch/clocks as an option in sports cars. With a button on the steering wheel, a driver riding alone could time himself.–*R. P. Algier, Highland, N.Y.*



A wrap-around heating clamp for instant soldering of copper pipe and fittings. All joining surfaces would be pretinned at the factory.–*Andrew Vena, Philadelphia.*



Snap-on baseboards of wood-grained plastic. They'd never need painting and could be removed to keep off spatters when the room is painted.–*Kirk Williams, Hopkins, Minn.*



Removable liners for fireplaces–a three-sided tray you'd pull out, take outdoors, dump, and hose off. No dust in the house!–*Rick Templeman, San Leandro, Calif.*

Everyone has his own pet idea of a gadget that he would like to see in general use. What's yours? We will pay $5 for each one published. Please use Government postcards only. Send to ILTS Editor, Popular Science, 355 Lexington Ave., NYC 10017. Write your name and address clearly. Contributions cannot be acknowledged or returned.

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Our Worst Bridge Disaster:

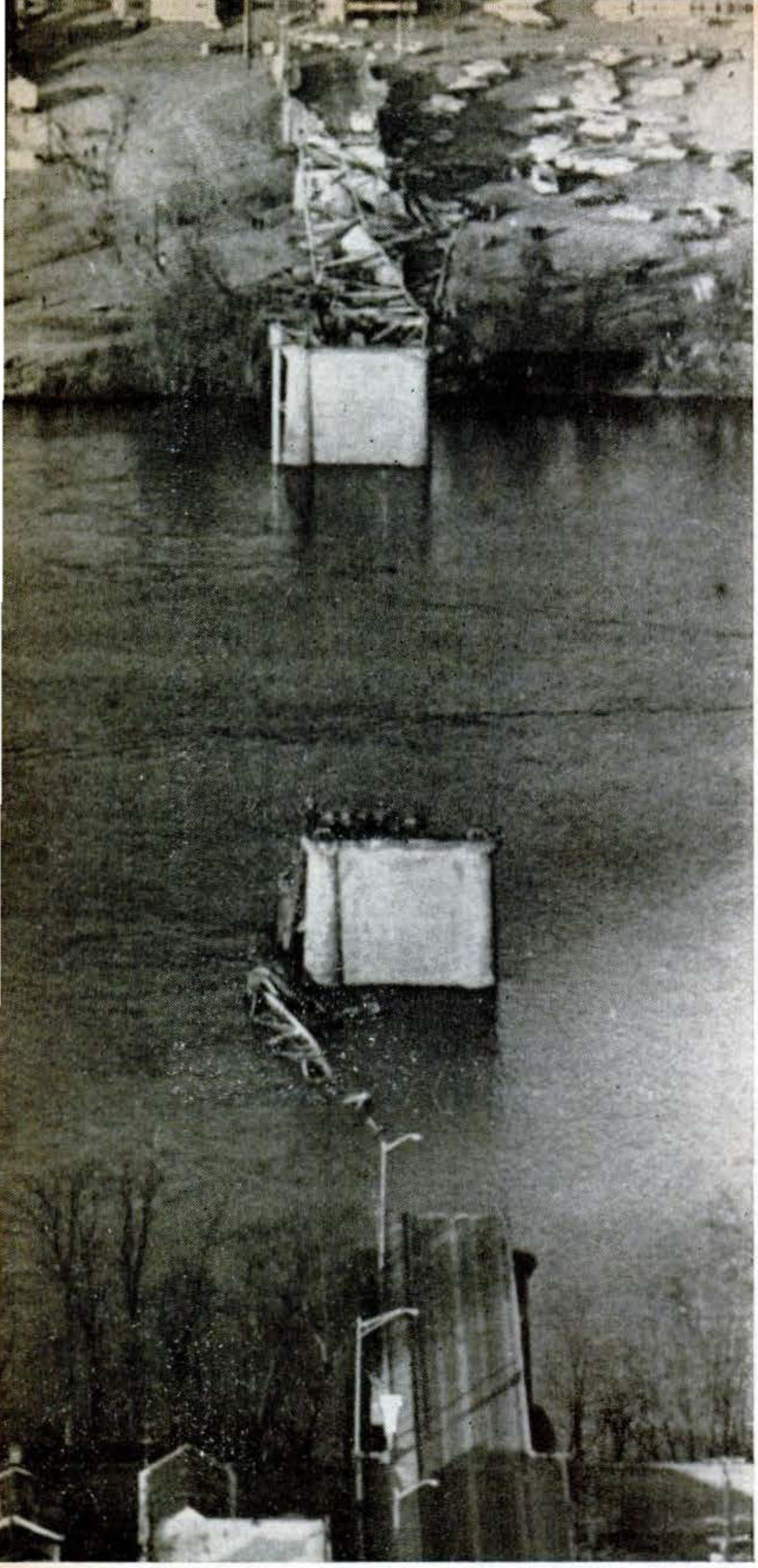
WHY

While the nation awaits the verdict of the experts seeking clues to one of history's most tragic bridge collapses, we have uncovered the startling story of the controversial engineering features of Silver Bridge across the Ohio, which will answer your concern about bridges you use

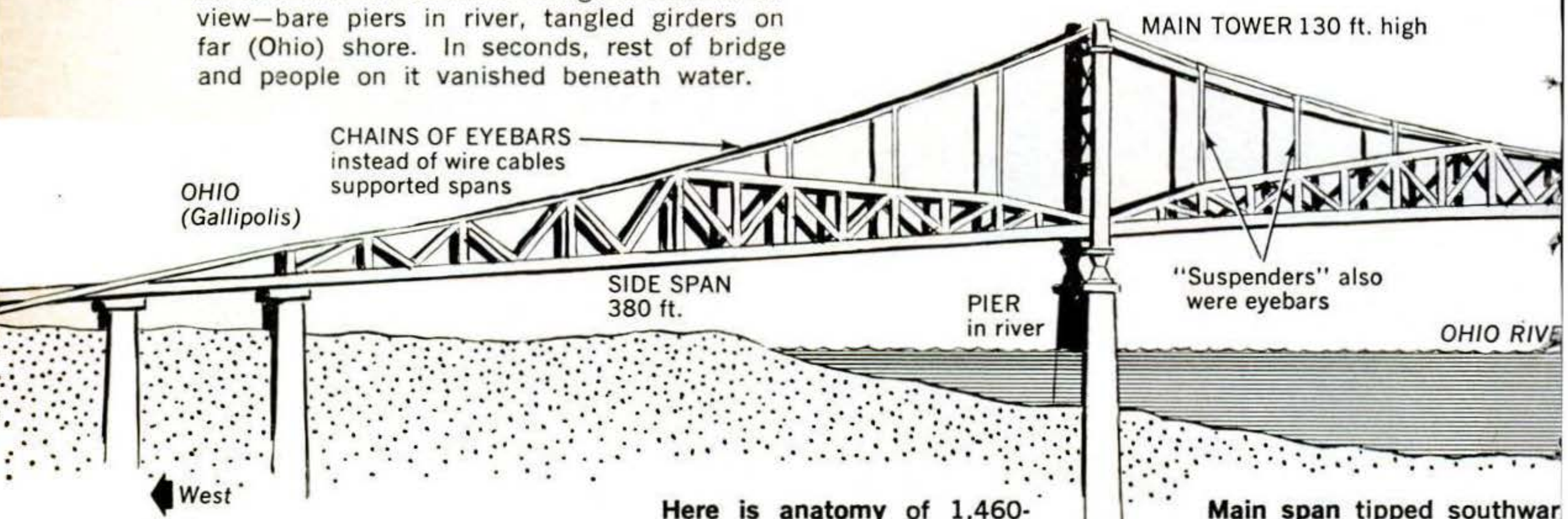
By ALDEN P. ARMAGNAC

It was all over in seconds—"a few" to 30, by horrified witnesses' estimates. Silver Bridge at Point Pleasant, W. Va., a two-lane suspension bridge whose three spans totaled 1,460 feet, collapsed from end to end and tower tops to piers—and vanished into the Ohio River. For most of the people in the cars and trucks that jammed it at 4:55 p.m. last December 15, there was no chance of escape.

At least 39 died, in vehicles pitched to the dark-brown water 80 feet below. That



All that was left of Silver Bridge is seen in air view—bare piers in river, tangled girders on far (Ohio) shore. In seconds, rest of bridge and people on it vanished beneath water.



Here is anatomy of 1,460-foot, three-span Silver Bridge. Collapse began with fall of the 380-foot span above.

Main span tipped southwar —in opposite direction fror way the Ohio-side one fell- and spilled cars and peopl

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Silver Bridge, in foreground, looked like this before it fell. It was a heavily traveled Ohio River highway crossing on U.S. 35, just downstream of a railroad bridge (background) that is still in use. Both this photo and the after-collapse photo on opposite page are from West Virginia side.

DID IT HAPPEN?

was the count by early this year, as divers and floating derricks continued the grim task of hauling up cars to recover bodies within. In toll of lives it looked like the worst U.S. highway-bridge disaster; a search of newspaper files and engineering journals found none before to match it.

What made Silver Bridge fall? Could it happen to the next bridge you drive over?

Overloading was the cause, said Prof. Thomas Stelson, head of the civil engineering department of Carnegie-Mellon University. Others agreed. The 39-year-old bridge was built to less demanding specifications than today's, which allow for the weight of modern tractor-trailers. But a mystery remained. Bridges have fallen before—but for a great steel bridge to fold up all at once and disappear is almost incredible.

President Johnson ordered a federal inquiry into the collapse—and into ways to assure the safety of the nation's other bridges. Additional probes began.

While clue-seekers puzzled over Silver Bridge's wreckage, PS tried delving into its original engineering. The hitherto untold story that resulted was filled with startling surprises.

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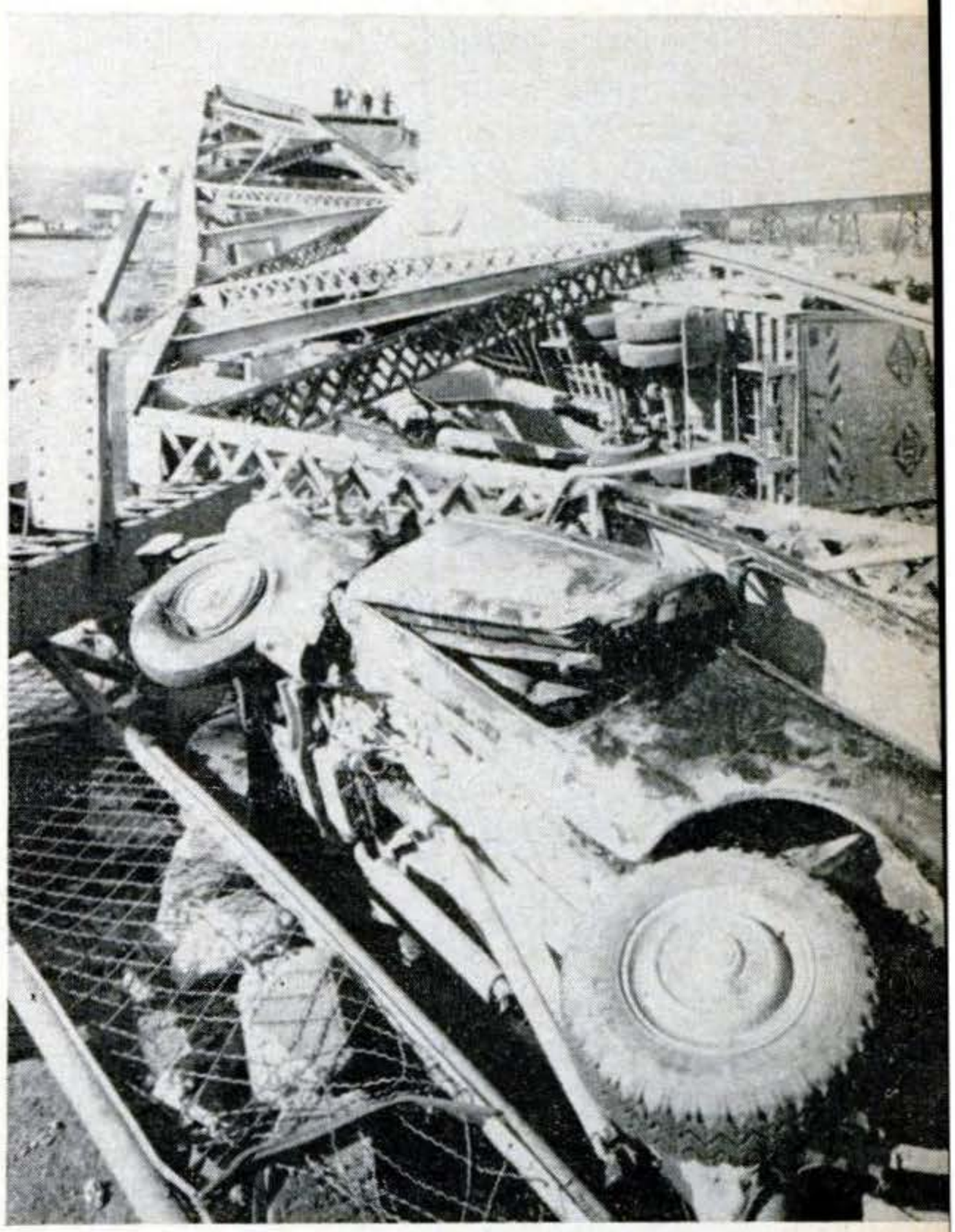
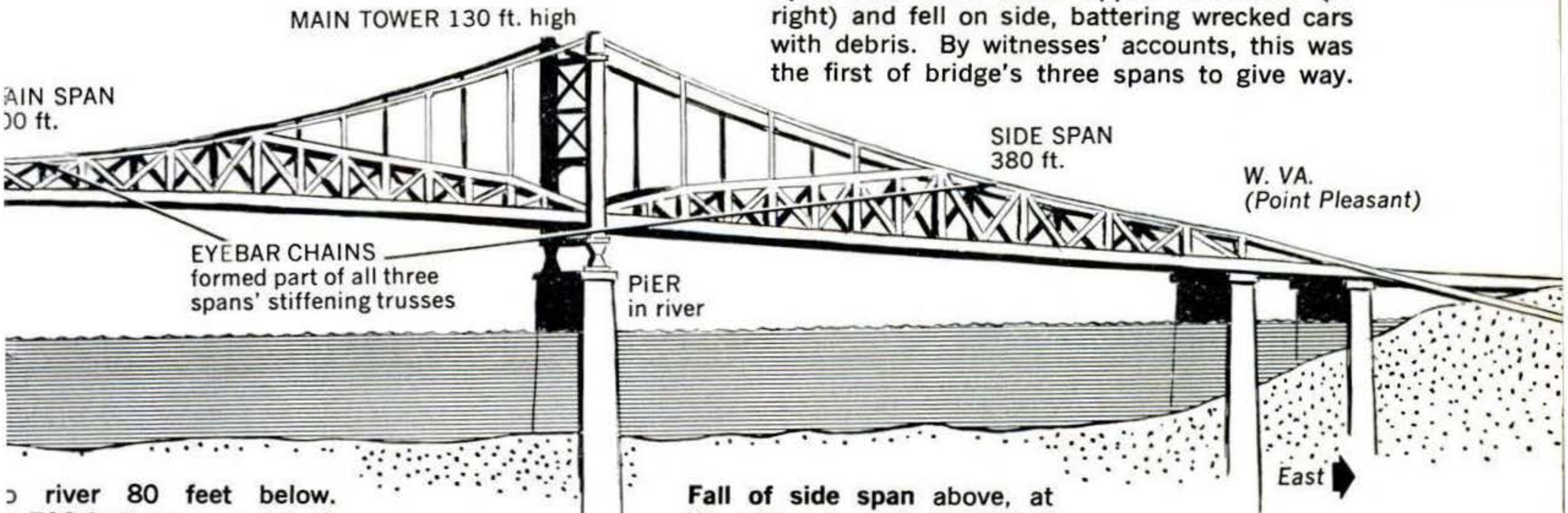


Span over Ohio shore tipped northward (to right) and fell on side, battering wrecked cars with debris. By witnesses' accounts, this was the first of bridge's three spans to give way.



river 80 feet below. e 700-foot span, and both the 130-foot main towers, shed down on top of them.

Fall of side span above, at West Virginia end, completed the destruction of all but the doomed bridge's piers.

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Radical features of bridge could have contributed to disaster—and at least

No ordinary bridge, Silver Bridge got its name because it was the country's first aluminum-painted one—but that was the least unusual thing about it. Its design was the very antithesis of conservative. It incorporated at least five radical features—some of them virtually thrust upon the bridge's designers, the J. E. Greiner Co. of Baltimore. Most could have contributed to the disaster, and at least one certainly did. These were the engineering novelties:

Eyebars instead of wire cables. The most conspicuous innovation of Silver Bridge was suspending it from chains of eyebars—instead of conventional suspension-bridge cables, made up of hundreds or thousands of parallel wires.

With its 700-foot main span, it was the first eyebar suspension bridge of its size in the U.S. In all the world, there had been only three large ones, including an eyebar suspension bridge built at Budapest in 1903 and another at Cologne in 1915. The world's largest, with a main span of 1,114 feet, was the Florianopolis Bridge in Brazil—a rail-and-highway bridge completed in 1926, only two years before Silver Bridge, and in many ways its prototype.

Raising sunken cars, to recover bodies of those killed outright or drowned, came first. Cutting and ripping away wreckage, to reach cars, unavoidably hindered examining it later for disaster clues.

Silver Bridge hung on two chains of eyebars. Each link of a chain consisted of two eyebars, side by side. A massive pin, passing through holes in the eyebars' enlarged and slightly thickened ends, joined each link to the next.

A link's two eyebars were supposed to share equally the 4½-million-pound pull on a cable. Some civil engineers, in professional-society discussions, voiced qualms. One eyebar conceivably might get more stress than the other, if it stretched less under tension, or if its pinholes were inadvertently spaced a trifle closer than the other one's.

Beyond dispute, at any rate, was the comment obvious to any layman: *A chain is no stronger than its weakest link.* And the question of how strong and uniform the links actually were brings up the Ohio River bridge's next radical feature:

Novel "high-tension" eyebars. Silver Bridge's eyebars were of heat-treated carbon steel—a new kind, just developed by the American Bridge Co. Their first use anywhere was in the 1926 Brazilian bridge; Silver Bridge was the first in the U.S. to use them. Before that, eyebars had been made of regular structural steel, or of nickel steel.

Eyebars of the new high-tension material, it was claimed, could be subjected to much more stress than had been safe before—with resulting economy in material, weight, and cost. And thereby hangs a curious tale:

Silver Bridge was to have been a wire-cable one. That type was originally recommended by the Greiner firm to the bridge's first owner—a private toll-bridge company, which later sold it to West Virginia. Likewise, a wire-cable design was first chosen for its prototype, the Florianopolis Bridge, by Robinson and Steinman of New York. In both cases that choice was overridden, when the American Bridge Co. convinced the economy-minded clients that an eyebar bridge would be cheaper. The designers had to revamp their plans.

First of the new eyebars made in quantity were the 400-odd for the Bra-

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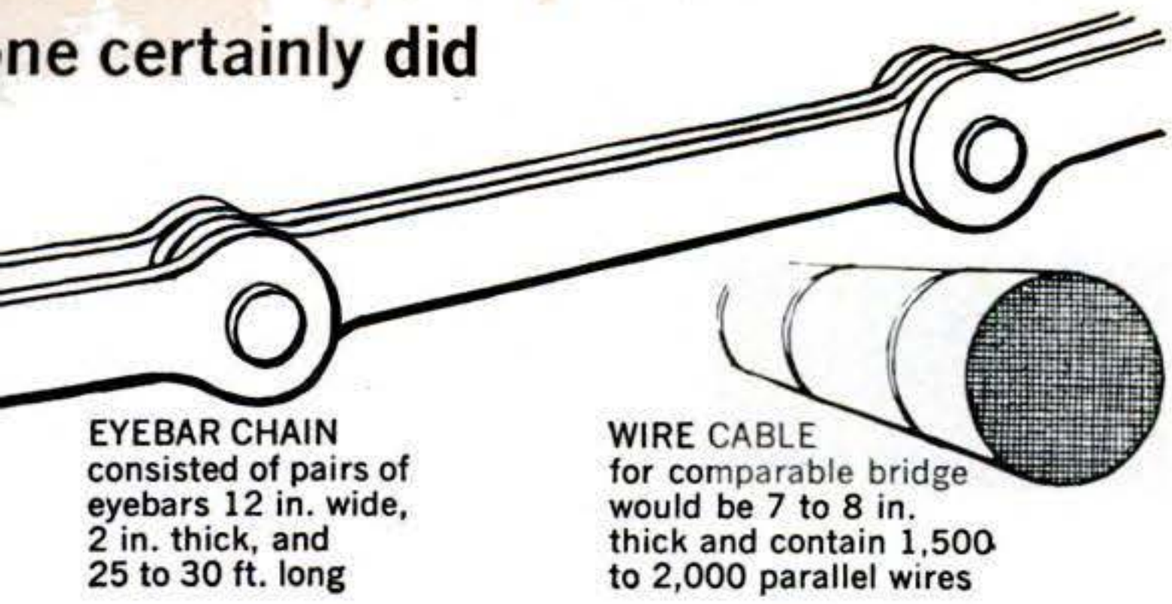


Chains of eyebars (top), instead of conventional wire cables (below), served to hold up Silver Bridge. It was the first eyebar suspension bridge of its size in this country—and one of few in the world.

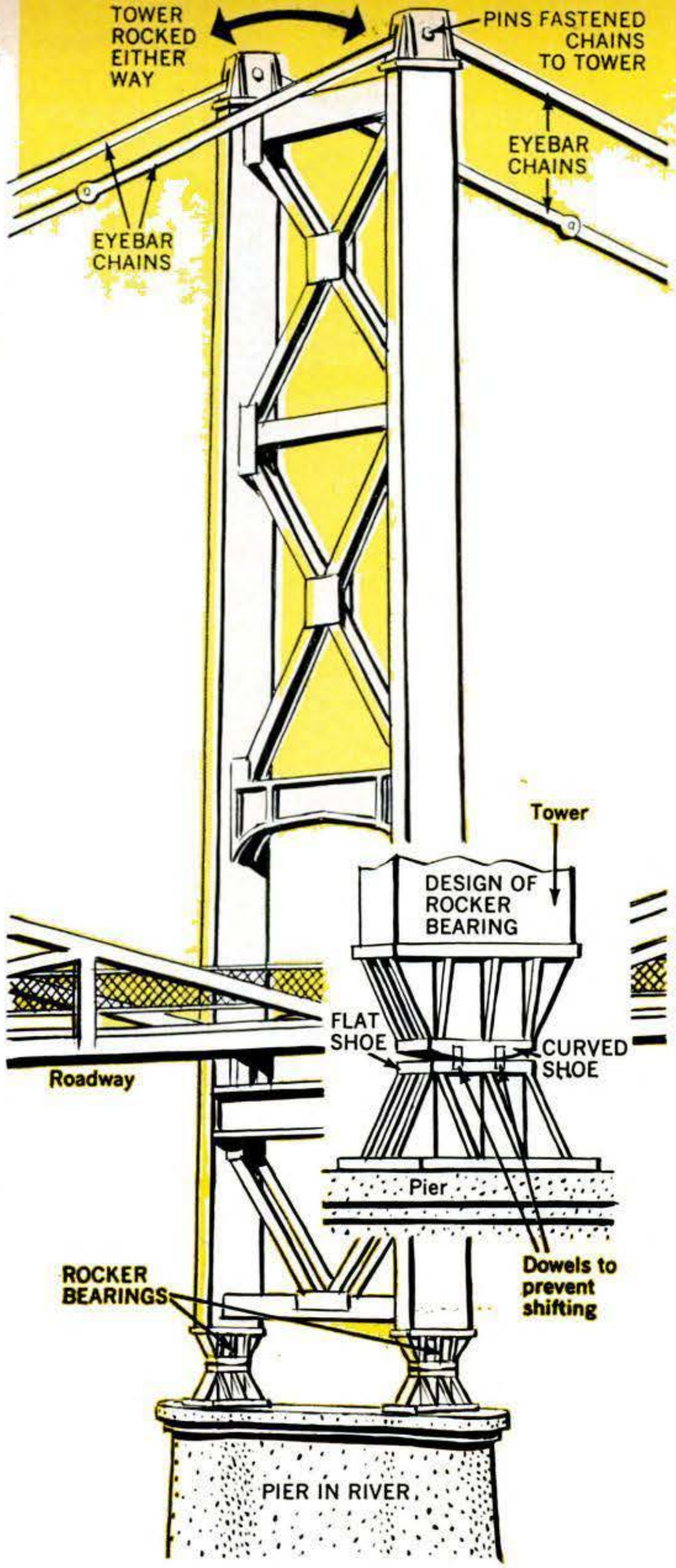
zilian bridge. Most were too long for a testing machine to check their quality. How they were made was the company's secret. (It was still experimenting, a spokesman said later.) And the bridge's noted co-designer, Dr. D. B. Steinman, in *Engineering News-Record* for Nov. 13, 1924, made one of the most extraordinary statements ever printed in an engineering journal: His firm declined to take any responsibility for the strength and safety of its bridge's eyebars—which was as much as saying, the safety of its eyebar-suspended bridge.

Designers of Silver Bridge had less reason for misgivings, since its shorter eyebars offered no testing problems—and the company's secrecy about its process had ended by 1927. High-tension eyebars were nevertheless something still regarded as new.

Double duty for eyebars. Silver Bridge's designers added a unique feature by building the eyebar chains into a part of all three spans' stiffening trusses, as top members. Florianopolis Bridge had pioneered in this, but for its center span only; Silver Bridge went it one better.

Due to this feature—and to a tower design to be described—Silver Bridge's structural elements were exceptionally dependent on each other for safety.

Unique anchorages. For lack of bedrock within economical reach, the eyebar chains ended in concrete blocks poured in shallow excavations, around the tops of hundreds of concrete piles. These novel anchorages were the only one of the bridge's radical features positively exonerated of contributing to the disaster; they were found intact afterward.



"Rocker" towers of Silver Bridge, one of first in U.S. to have them, swayed freely on curved bases. This provided for movement of eyebar chains, pinned to tops, with varying temperatures and loads. Rocker design, later used widely, was sound and advantageous—but relied on eyebar chains to hold towers up. If the chains broke, or went slack, the rocker towers would fall—and Silver Bridge s towers did.

"Rocker" towers. On the face of it, one innovation—rocker towers—must have contributed to the magnitude of the Silver Bridge tragedy.

For comparison, rigid towers of masonry or steel supported our earliest large suspension bridges. The towers'

[Continued on page 188]

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Checking speed: Fifth wheel and accurately calibrated electric speedometer show true figure regardless of wheelspin or wheel-locking.

The liveliest of the compacts was the Dart with 145-hp. slant-six. Norbye and Dunne agree it's the most fun-to-drive car in the group tested, but it's not the compact either of them would pick for himself for all-around use.

NORBYE · DUNNE
PS CAR TEST
REPORT

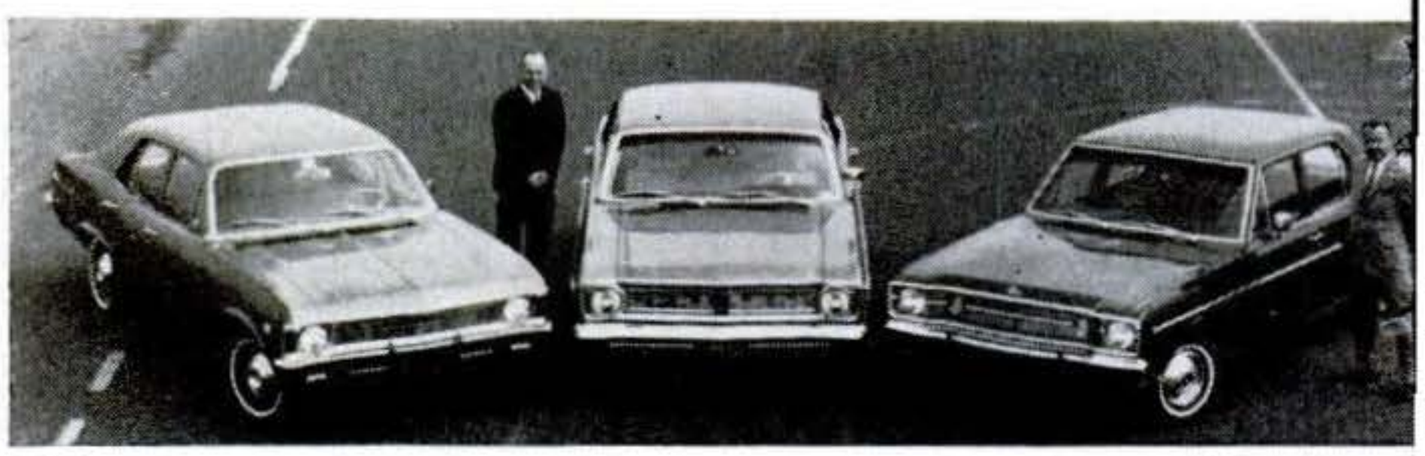
We believe the Norbye/Dunne Report is the best car-testing formula achieved by Popular Science in 20 years. It is far more than a seat-of-the-pants impression. Test conditions are rigidly controlled, and test results are recorded with the most modern instruments: a Tracktest "fifth wheel" (speed), a Tapley meter (deceleration rate), a Mintex pressometer (pedal pressure). Every car is put through a unique standardized handling test. Finally, the results are impartially analyzed by an outstanding two-man team and reported to you.

Ernest V. Heyn
Editor-in-Chief

These compacts are bigger and better than ever

CHEVY II
FORD FALCON
DODGE DART

Maybe you don't expect much from a lowly six-cylinder "fleet-model" compact. Brother, we've got news for you



Lining 'em up: Chevy II, Falcon, and Dart are shown with PS testers Dunne and Norbye. Chevy II is heaviest, Falcon lightest.

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By JAN P. NORBYE / *PS Automotive Editor* and JIM DUNNE / *PS Detroit Editor*
PHOTOS BY BILL MORRIS

These three compact cars are really super-compacts—much larger and roomier than the Corvair or the Rambler American, just a bit smaller than the intermediates. They are smart-looking, and their quality and finish are superior to earlier compacts. But make no mistake: They are lower-grade cars than the bigger models from the same makers. There are few touches of luxury, and sound-deadening is skimpy.

Because most compacts are built with six-cylinder engines, we picked the standard six of the best-selling Chevy II and the closest comparable power units from Ford and Dodge. These cars were designed to provide basic transportation, so we included no power assists. During the Ford strike, the only available Falcon that met our mechanical specifications carried optional radial-ply tires.

Besides comparing the brakes, acceleration, handling, and fuel economy of these three compacts, we'll tell you:

- Which car ran noisiest.
- Why the Chevy II is easier to drive in heavy traffic.
- Which car needs a bigger engine.
- What's wrong with Falcon's brakes.

BRAKES This test shows a car's ability to stop quickly, in a straight line, after repeated use of the brakes (as in stop-and-go highway traffic). Ten stops from 60 m.p.h. at one-minute intervals with half-g (16 feet per second per second) deceleration are followed by a final stop for maximum deceleration (minimum braking distance) from 60 m.p.h. in a 12-foot lane without wheel locking.

Results	Distance	Pedal Pressure
Chevy II	156 ft. 1 in.	85 lb.
Falcon	171 ft. 4 in.	200+ lb.
Dart	164 ft.	120 lb.

All three cars had drum brakes without power assist. With cool brakes, it took 55 pounds' pedal pressure to stop the Chevy II from 60 m.p.h. in 240 feet, 45 pounds in the Falcon, 65 pounds in the Dart. During warm-up, pedal-pressures rose sharply in the Ford and Dodge, negligibly in the Chevy. By the final stop, the Falcon brakes had faded so badly that no amount of pedal pressure could stop the car any quicker. The rea-

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Brake test: Chevy II came out best in all phases, its drum brakes equal to some disks we've tested.

Lane change: Chevy II resists turning (understeer), and rear end breaks away in the middle of the turn.

son lies partly in front/rear effectiveness (front wheels must do more than their share of braking), partly in Ford's lining material (drums and linings overheat).

ACCELERATION The 0-60-m.p.h. test is intended to show a car's ability to reach cruising speed from standstill. The 0-80-m.p.h. test shows its high-speed power reserve. The 25-70-m.p.h. test simulates a highway merging situation or passing on a two-lane road.

Results	0-60	0-80	25-70
Chevy II	16.4 sec.	31.3 sec.	20.6 sec.
Falcon	19.1	—	22.8
Dart	15.7	29.6	19.8

Falcon's performance is sadly marginal for turnpike drivers who must accelerate quickly to merge with high-speed traffic. Power flattened out at 65, and we could not get above 72 m.p.h. on the long straightaway at Bridgehampton race circuit. In other words, there's no power reserve for high-speed passing. Ford should standardize the 240 six in the Falcon. The modern big six comes in the Ford Galaxies, but it is not even optional in the Falcon.

LANE CHANGE This test shows a car's ability to make an emergency maneuver at cruising speed. The right lane is blocked at a given point. The left lane is blocked 120 feet beyond. Each car makes the two lane changes in succession, and the test is repeated until safe maximum speed is established.

Results: Chevy II, 55 m.p.h.; Falcon, 57 m.p.h.; Dart, 55 m.p.h.

The high-speed handling of the Chevy II belies its taut, road-hugging appearance. Like the Camaro (tested last month), it suffers from delayed steering response. When the car actually does swerve, the tail begins to break away (though it does not swing violently.) The Dart had trouble regaining directional stability after a turn, and body roll was unexpectedly strong. The Falcon was completely obedient and remained fully controllable, even after wheel breakaway set in. The Falcon's radial-ply tires no doubt improved steering-wheel response.

MANEUVERING This test shows a car's ability to negotiate narrow, winding roads or heavy city traffic with sharp corners, stopped buses, and double-parked trucks. The car is driven as fast as possible on a snake course through pylons spaced at 48 feet.

Results: Chevy II, 25 m.p.h.; Falcon, 27 m.p.h.; Dart, 24 m.p.h.

The body leans and the tail swings but the Falcon stays under control. Speed was limited by wheelspin as the inside

Maneuvering: Falcon was the fastest, but lifted the inside rear wheel, losing speed due to wheelspin.

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Lane change: Falcon responds beautifully to helm but, like Chevy II, suffers from rear-end breakaway.

rear wheel was lifted off the ground. The Dart rolls and weaves through the test grid, until excessive winding of the steering wheel holds speed down. The Chevy II has little body roll but the tail breaks away early, exaggerating the maneuver and slowing the car.

FUEL ECONOMY

Results: Chevy II, 18.8; Falcon, 19.1; Dart, 17 m.p.g. These small differences are proof that gas consumption depends more on vehicle size and weight than on engine displacement and power. Chevy II's good economy indicates a wind-cheating body, and Dart's poor mileage probably is a result of using a "shorter" axle ratio. Radial-ply tires no doubt helped the Falcon's performance.

BEST FEATURES

Chevy II has new styling for '68. It looks more up-to-date than the carry-over bodies of its competitors. The Fisher body proved rattle-free and had little wind noise. We also liked:

- Synchronized first gear that is easily engaged at speed, giving the Chevy II a great advantage in city traffic.
- Windshield wipers and heater fan that are hardly audible when in use.
- A pedal-operated parking brake of sound design.
- Convenient knob-controlled air intakes for the ventilation system.
- Twist-knob on glove box (a safety design that also gives improved locking).

Falcon scores for quiet—a characteristic it shares with all the Ford line. A tight body well insulated from road noise, aided by radial-ply tires, gave an unusually quiet car at speed. Wind noise also was practically nonexistent throughout its speed range. More praise:

- Interior trim is richer looking than in the other compacts. You could think you were in a higher-grade car.
- Squeeze-type door handles are safe and practical.
- Instrument panel is well laid out and dials are easy to read.
- Heater fan has three speeds, and it is installed *outside* the passenger compartment.

Dart is the most fun-to-drive compact. This has been true for years—you sit higher up and have a commanding view of the road ahead. The car responds with sureness and agility. In traffic, it is surprisingly brisk, though it's no highway cruiser. GM and Ford, please copy:

- A little light shines on the ignition switch as the driver's door is opened, then turns off after about 90 seconds. You'll love Dodge for this every time you get into the Dart after dark.
- Proper gauges for engine temperature and alternator (but idiot light for oil pressure).
- Box-shaped trunk with flat floor holds more than other compacts.

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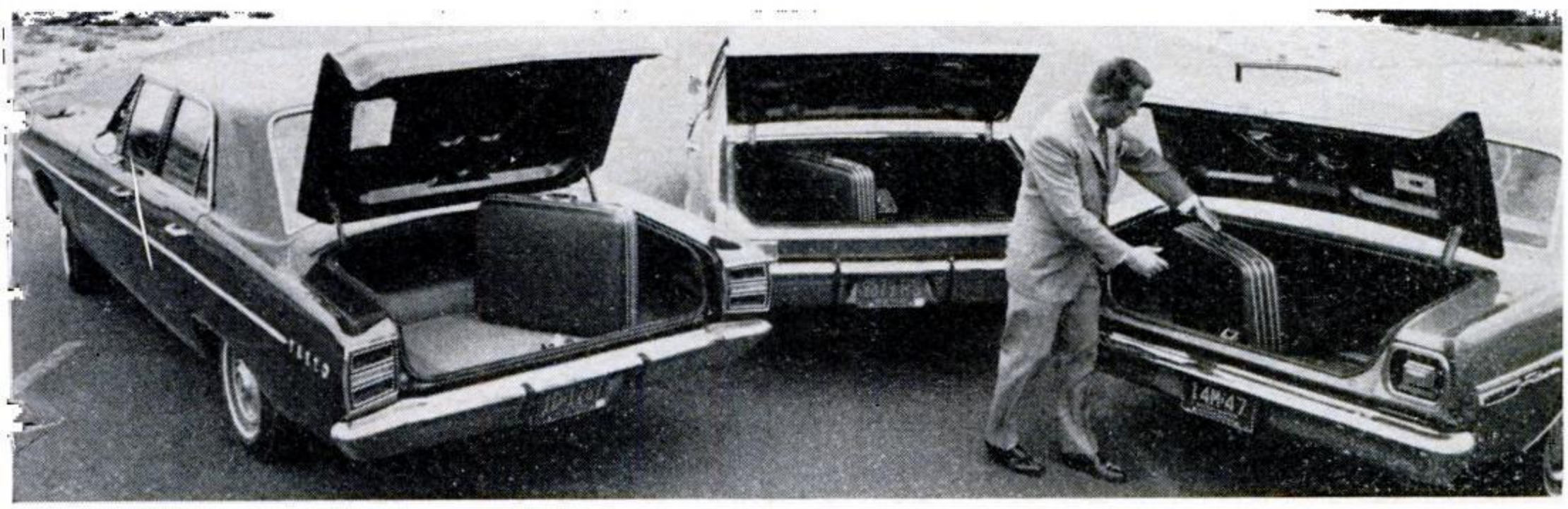

Luggage space: Dart (left) has biggest trunk (14.1 cu. ft.) with lowest lift-over height. Chevy II (center) has deepest trunk, but spare wheel cuts space to 12.4 cu. ft. Falcon's trunk is the smallest (12.3).

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Falcon rear door opens almost to right angle, and step height is low enough to allow a small child to enter the car without help from others.

Chevy II rear seat is wide enough for four kids but not comfortable for three adults on a trip.

Dart's doors, front and rear, are wide, with long sills that make for easy entry and exit. The automobile has huge glass area and good visibility.

WORST FEATURES

Chevy II rear seat room is minimal for three passengers. The other cars have wider rear seats. We think this the worst feature of the Chevy II, and that shows you what a well-designed car it is. A few minor flaws:

- Light, wiper, and ignition switches are labeled in the same color as the panel—difficult to read in daylight, impossible at night.
- Recessed safety knobs on radio are hard to use. There must be a better way to combine function with safety design.
- Trunk is wide but short and loses room to the spare—plunked in the middle.

Falcon lack of power is its worst feature. This gave rise to more complaints during our tests than anything we criticized on the other cars. Further gripes:

- Vital small controls on the instrument panel are not lighted for night use.
- Trunk space is small. Luggage for two seems to be its maximum capacity.
- Horn ring is too low for easy reach.

Dart has high noise level as its dominant bad feature. Road noise gets through to the interior with alarming ease; engine noise is louder than in the other compacts; wind leakage is audible at the front vent windows; the manual transmission has a gear whine; and the heater fan, placed under the instrument panel, is obtrusively noisy. Other dislikes:

- Steering wheel feels "waxy" and quickly loses its new-car shine.
- Air vents in cowl are opened manually by reaching under the instrument panel.
- Turn-signal stalk lacks a lane-changer device.
- Slant-six engine offers less accessibility to plugs and distributor than vertical sixes in the other compacts.

CONCLUSIONS

NORBYE: I'd pick the Falcon if it only had more power. It's a quiet, comfortable, fine-handling car, but it can hardly get out of its own way. The Chevy II is my choice, mainly for its excellent brakes, the rugged vibrationless engine, and the all-synchro gearbox.

DUNNE: There's no doubt at all in my mind—the Chevy II gets the nod over the Dart on the basis of its newer styling and lower noise levels. PS

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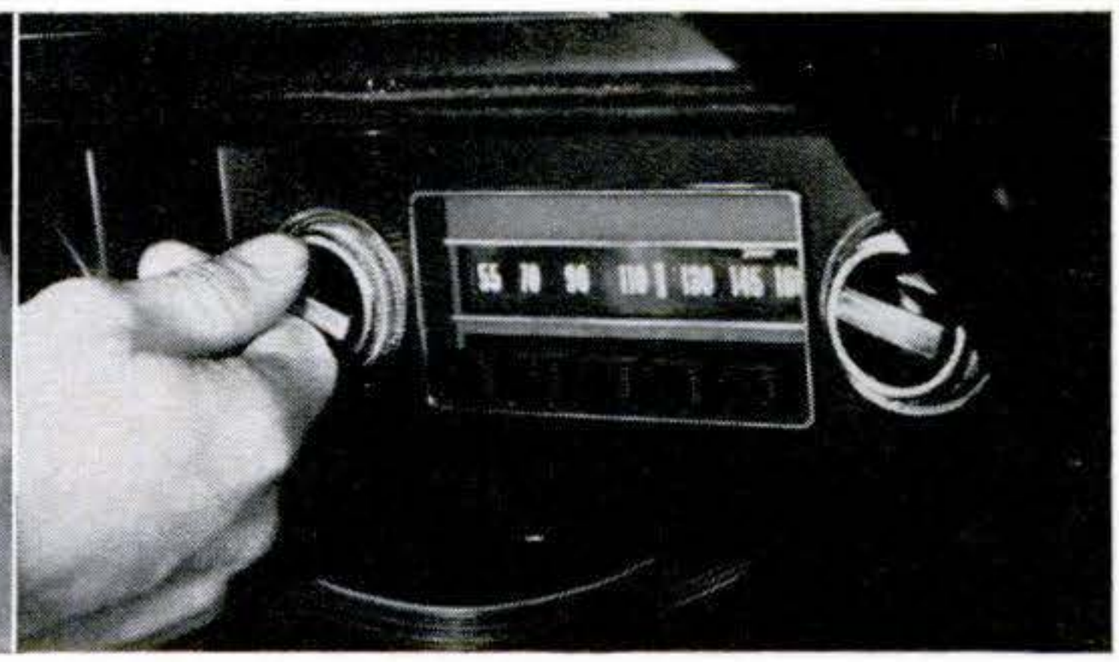
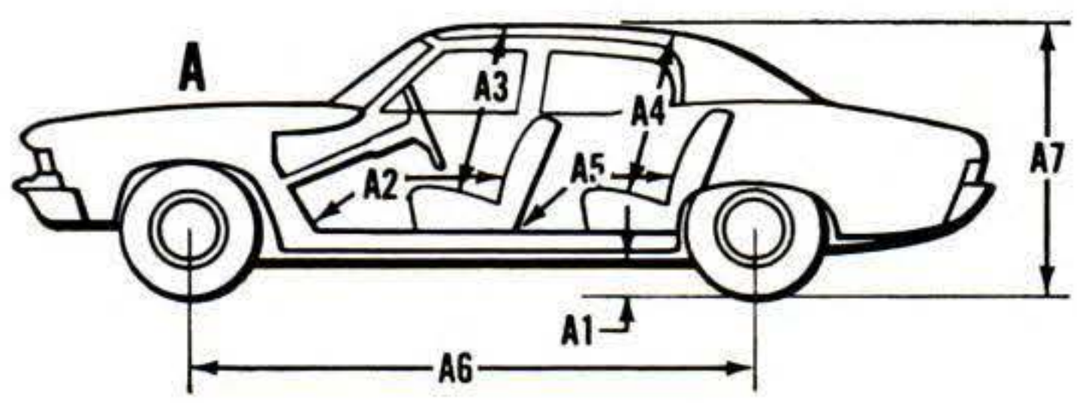
Flat floor in the Dart trunk was made possible by locating the spare wheel next to the fuel tank.

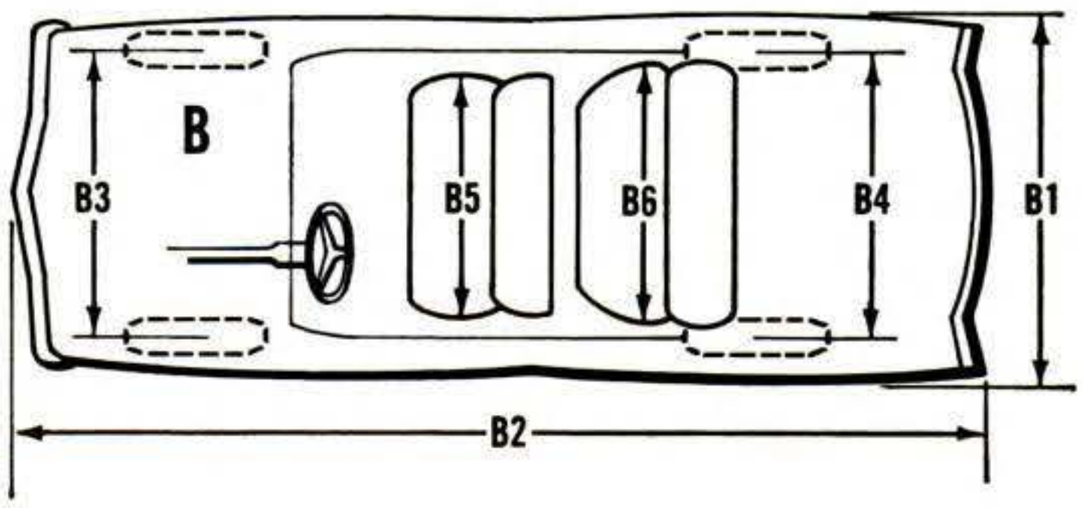
Chevy II's lift-over height is 23.2 inches, compared with 21.9 on the Dart and 23.1 in the Falcon.

Some drivers prefer Dart's parking brake to the floor pedal designs used on other compacts.



Radio knobs in Chevy II have recessed bar for turning—but accurate adjustment proved to be difficult.





	CHEVY II Nova	DODGE Dart	FORD Falcon
DIMENSIONS (inches)			
A1 Ground clearance	5.7	5.5	5.9
A2 Front leg room (max.)	41.6	41.7	42.4
A3 Front head room	38.8	38.3	38.8
A4 Rear head room	37.2	37.3	37.7
A5 Rear leg room (min.)	35.3	35.7	33.9
A6 Wheelbase	111.0	111.0	111.0
A7 Overall height	54.1	52.8	55.0
B1 Overall width	70.5	69.7	73.5
B2 Overall length	187.7	195.4	184.3
B3 Front track	59.0	58.1	58.8
B4 Rear track	58.9	56.3	58.5
B5 Front hip room	56.7	57.2	59.5
B6 Rear hip room	55.1	57.2	59.5
SPECIFICATIONS			
Engine type	OHV six	OHV six	OHV six
Bore & stroke	3.85 x 3.25 in.	3.40 x 4.125 in.	3.68 x 3.13 in.
Displacement	230 cu. in.	225 cu. in.	200 cu. in.
Compression ratio	8.5:1	8.4:1	8.8:1
Carburetion	Single 1-bbl.	Single 1-bbl.	Single 1-bbl.
Power @ r.p.m.	140 @ 4,400	145 @ 4,000	115 @ 3,800
Torque @ r.p.m.	220 @ 2,400	215 @ 2,400	190 @ 2,200
Transmission	3-speed manual	3-speed manual	3-speed manual
Axle ratio	3.08:1	3.23:1	3.20:1
Tires	Goodyear	Goodyear	B. F. Goodrich
Tire size	7.35-14	7.00-13	185R-14
Steering ratio (overall)	28.3:1	28.7:1	29.4:1
Turns, lock to lock	4.8	5.3	5.25
Turning diameter	38.4 ft.	38.7 ft.	39.8 ft.
Brakes	All drums	All drums	All drums
Brakes, swept area	268.6 sq. in.	254.5 sq. in.	212 sq. in.
Curb weight	3,030 lb.	2,880 lb.	2,831 lb.
Basic price	$2,291.00	$2,334.00	$2,277.84
Price as tested	$2,378.50	$2,442.90	$2,421.14

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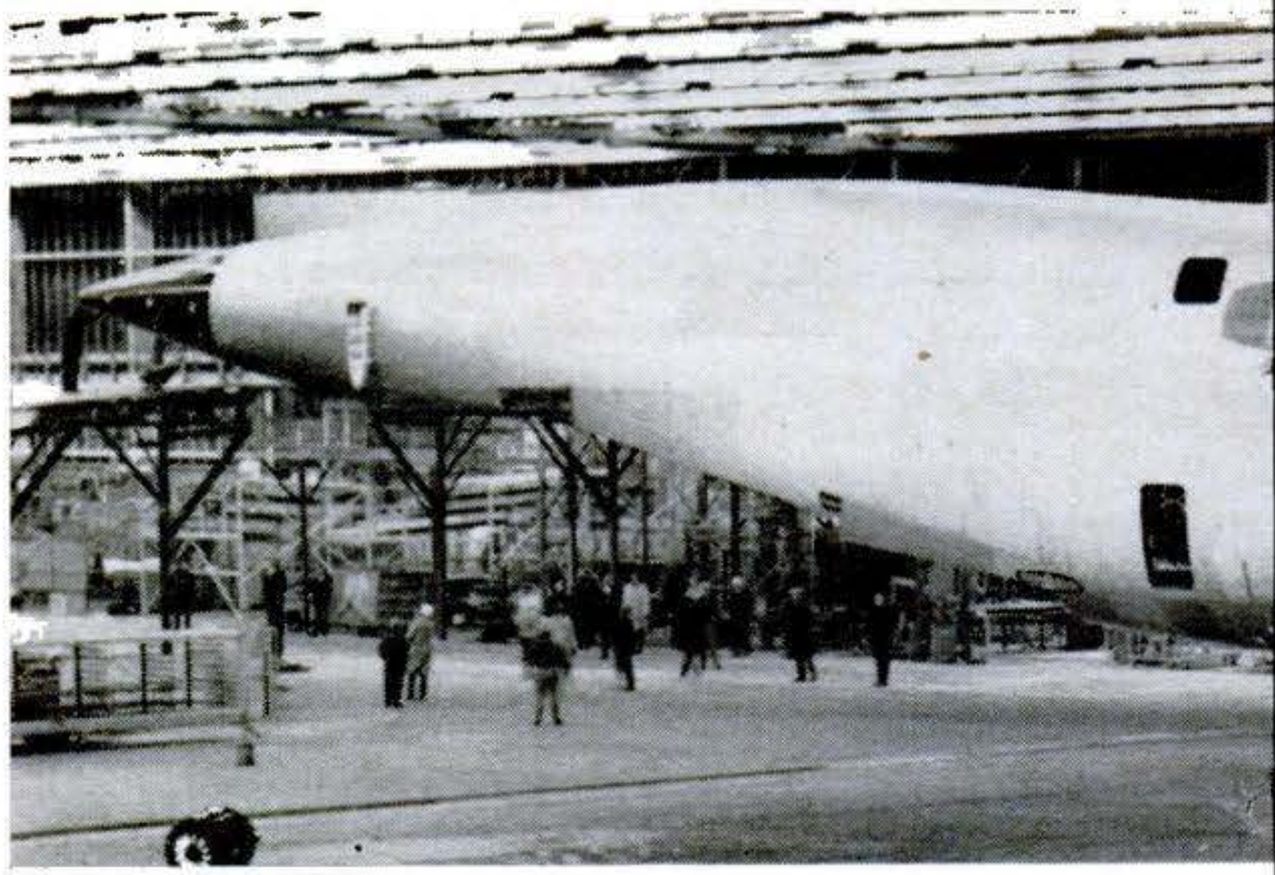
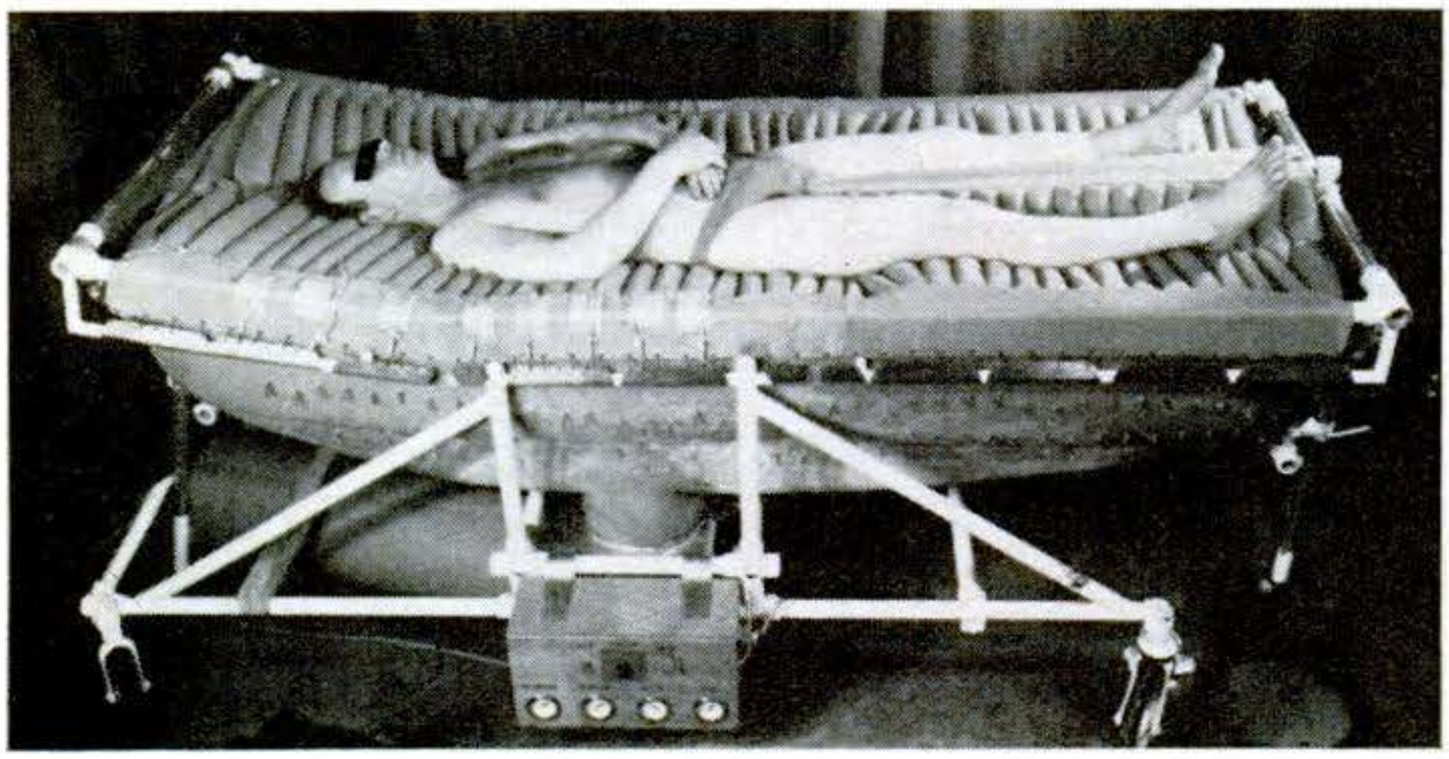
Biggest plane ready for wings

The fuselage of the world's biggest airplane was inched out of one huge building dock and into another the other day. The Air Force's C-5A Galaxy, which will weigh 728,000 pounds when complete, was being moved from a body-mating jig the size of a yacht drydock to a second jig for attachment of its wings. It will fly next June. The Galaxy could hold six interstate buses parked in two side-by-side rows. The plane will be 246 feet long and span 223 feet wingtip to wingtip. Fifty-eight of them are on order.



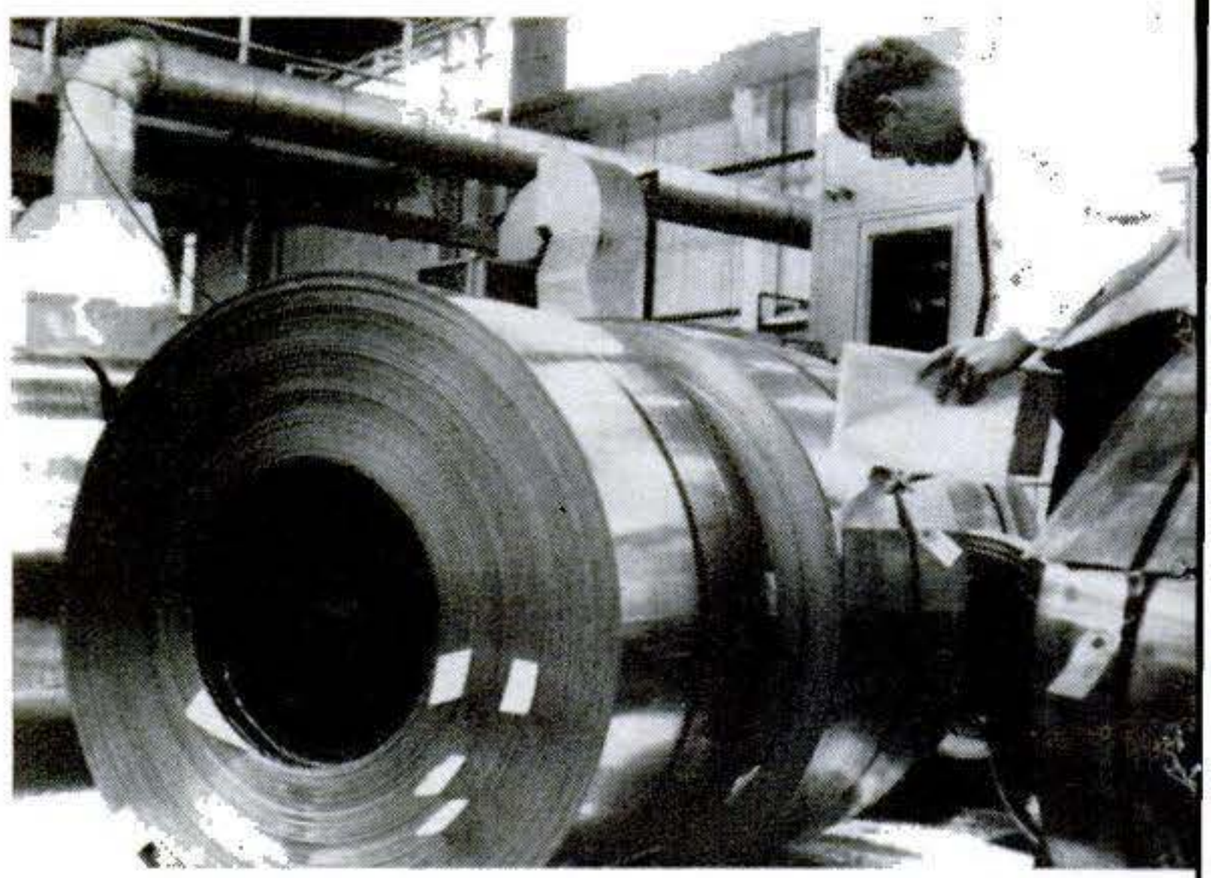


This bed is just air

This bed and the hovercraft on the opposite page have something in common—a sort of segmented mattress that serves a similar purpose. A blower injects warm, sterile air into the mattress pockets and tiny jets bleed it out so that a hospitalized person who is badly burned is supported on air. A British product, it's called a Hoverbed.

Horse gets a radioelectrocardiogram

The horse galloping in the background above is getting a radioelectrocardiogram at the hands of veterinarian G. F. Fregin. Electrodes on its skin and a tiny radio transmitter do the trick. The recorder in the foreground reported that the normal heartbeat of the horse (30 to 35 a minute) ran as high as 260 during hard exercise.



What money looks like in the raw

Each of these rolls of metal will be $172,700 in coins presently. They're money in the raw. Produced by the materials division of Texas Instruments, they have a solid copper center and a nickel-alloy surface. Each roll weighs 12,560 pounds. The U.S. mint bangs the clad stock into coins that are replacing ones of silver alloy.

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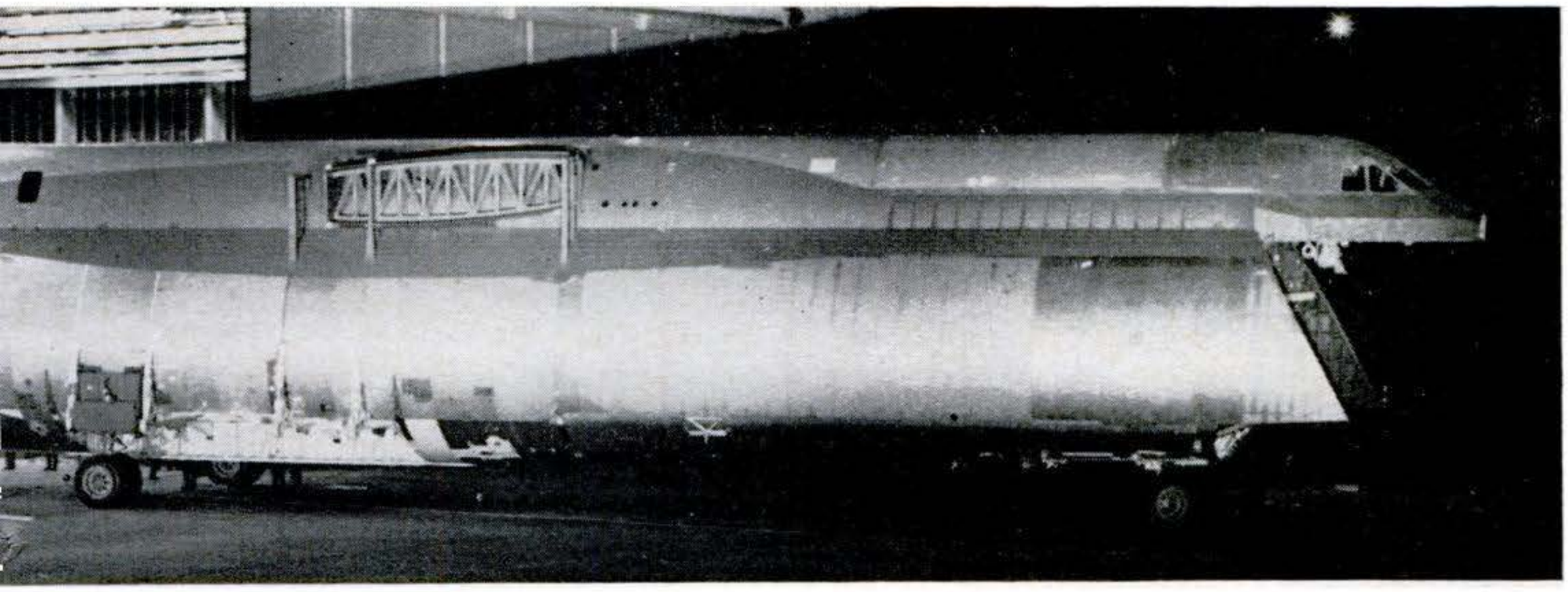
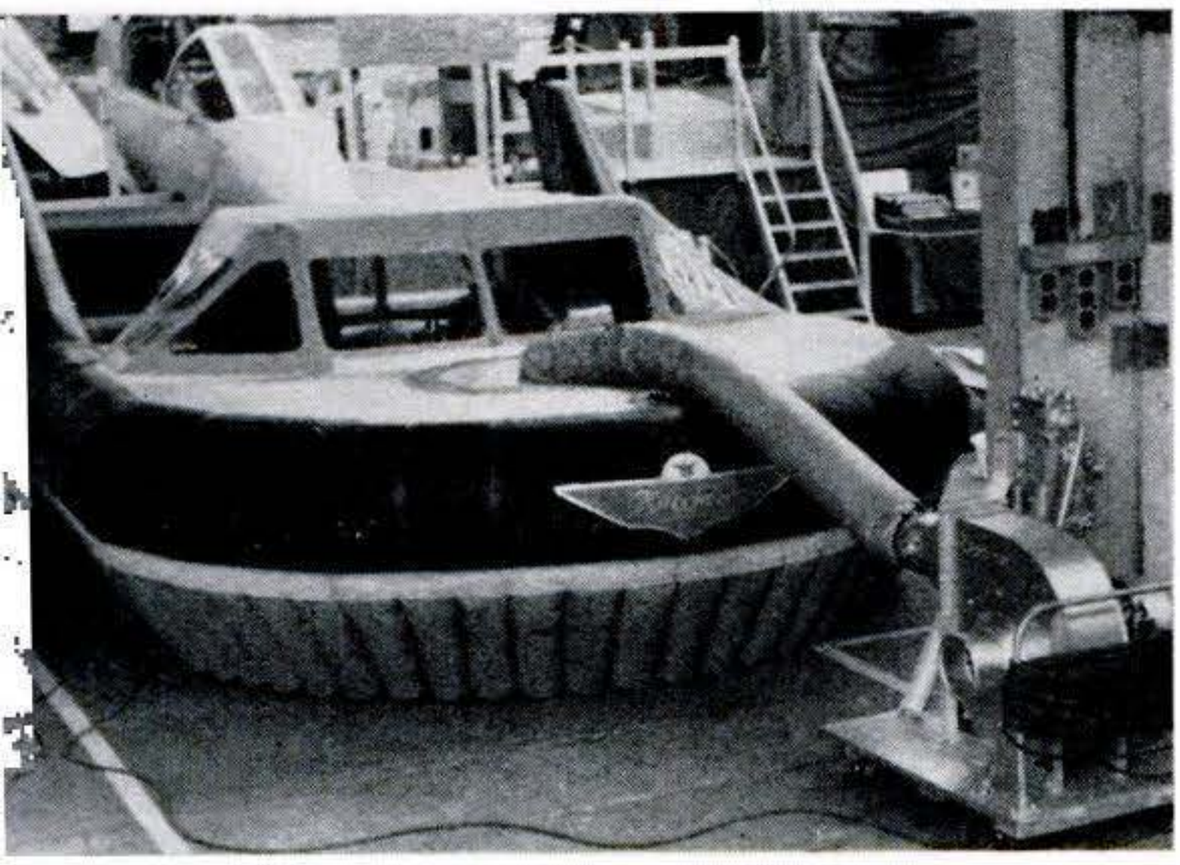


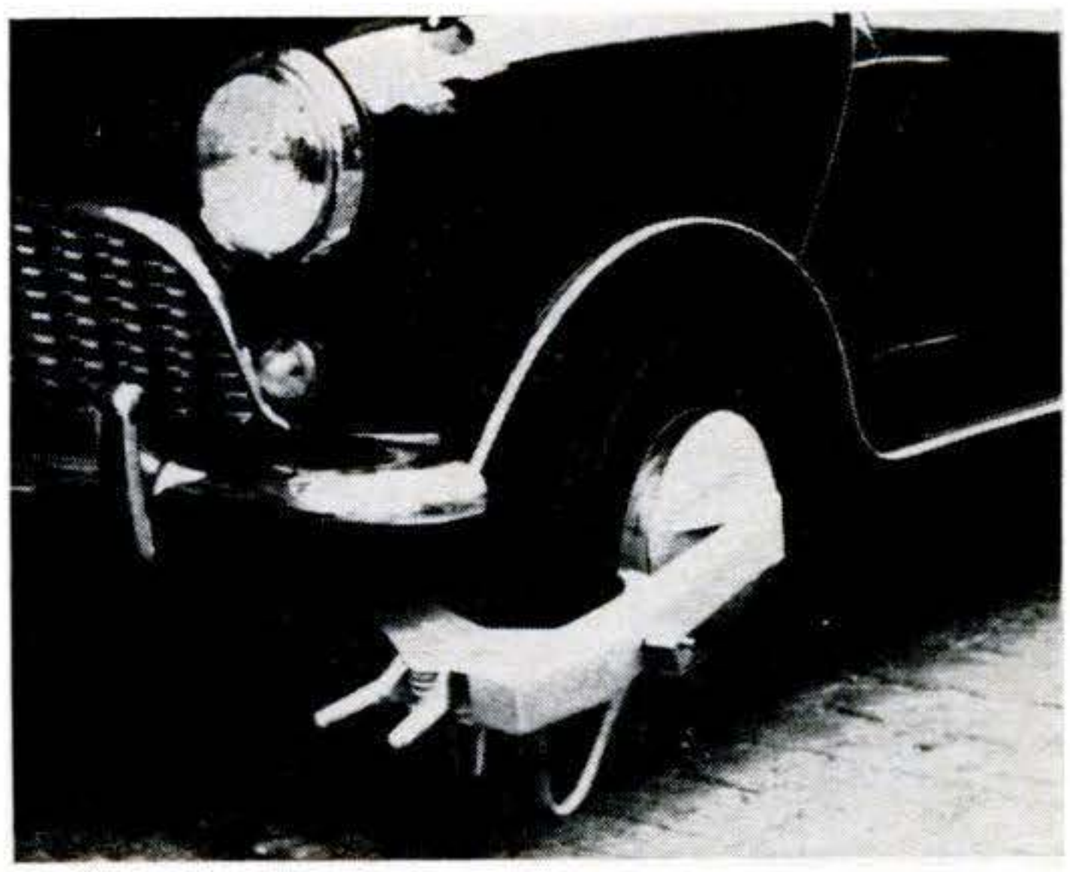
Beachcomber—1968 style

A machine for picking up cans, broken bottles, and other litter from beaches has been tested at Ft. Lauderdale, Fla. It works. And you will never guess what it was developed from—a machine for removing stones and rocks from potato fields. Called the Scavenger, it's made by the Lockwood division of Seilon, Inc., Gering, Nebr.



Hovercraft is a bag of air

Now comes the ultimate in hovercraft—one that packs into a bundle measuring 3½ by 3½ by two feet. Full of air, inflated by a small blower, it stretches to 19 feet. The lift fan and pusher prop are driven by two Volkswagen engines. It was designed in England. See how the "skirt" resembles the air-bed mattress on the opposite page.



Police clamp offending car to spot

In some U.S. cities, police tow away illegally parked automobiles and make owners bail them out of a pound. Paris police do it differently—they just clamp such cars right to the spot with a wheel lock for which they hold the key. The owner can drive off only after he has paid his fine and the gendarmes remove the clamp.

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1 Belt sander makes quick work of removing old paint and exposing a smooth, raw-wood surface needed for proper application of the Vectra fabric. Use a coarse abrasive to leave a "tooth" on surface.

2 Disk sander in a ¼" drill does a good job of smoothing dents and snags where filler has been applied over heads of hull fasteners. Take care not to gouge the wood or remove more than necessary.

New Life for an Old Boat!

Latest rival to fiberglass for fabric-resin boat overlay offers many advantages and fewer headaches

By CHARLES R. MEYER

Working with Vectra polypropylene fiber will bring a pleasant surprise to anyone who has ever tried fiberglassing a boat. If you've only read about "glassing," but haven't worked up the nerve, yet, to try it yourself, Versatex (the fabric made from Vectra) will make your first effort a lot easier and more agreeable.

Any properly applied, fabric-reinforced plastic skin will do wonders for wooden boats: banish leaks forever, eliminate periodic caulking, strengthen weakened hulls, and give improved appearance with minimum maintenance. Fiberglass, Dynel, or Vectra marine fibers will do the job. The first two are well known in the marine field. The third, Vectra, is a rev-

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3 Portable router with a carbide-tipped cutter and an edge guide is the quickest way to clean up the edge of the strakes. Set the guide to remove least possible amount of wood for a clean surface.

4 If you want extra abrasion resistance for occasional beaching, put an extra layer of fabric and resin over the keel. Apply this narrow strip and let resin harden before applying full-width fabric.

5 Resin and hardener must be carefully measured and thoroughly mixed immediately before using. Hardening time depends on temperature. Mix small batches to find out how much you can use in time.

6 If you let the mixed resin sit too long in the container, here's what happens. Resin starts to harden prematurely and the batch must be discarded. We could use a full quart before it hardened.

Versatex fabric is so light it floats, yet it's tough and strong

olutionary polypropylene olefin fiber used in ladies' hosiery and only recently applied to boat hulls. Here are some comparative specifications:

	GLASS	DYNEL	VECTRA
Specific gravity	2.54	1.34	.90
Stiffness, grams/denier	322	88	50
Toughness, grams/denier	.07	1.2	1.6
Strength, grams/denier (dry)	7-8	2.5-3	7-8
Strength, grams/denier (wet)	4-5	2.5-3	7-8
Peel strength from plywood, lb./in.	10.1	28.8	32.8
Abrasion resistance	fair	good	excel.
Ease of resin impregnation	fair	excel.	excel.

Vectra does not absorb moisture or lose strength when wet; it is so light it floats; it's easy to stretch, has extraordinary resiliency that lets it "give" with hull pressures without rupturing. It has no "fly"—the tiny hairs that come off fiberglass strands—to cause irritation and itching when you work with it.

In the process of sheathing three 16-19-foot outboards during the past season, I've seen two turn out magnificently—and the third "botched." You must know what you're doing or risk disaster.

For a 16-footer, figure approximately $35 in cloth, another $50 for five gallons of polyester resin. There is no necessity to apply the cloth above the waterline, in my opinion. Overall, not counting labor, $100 will do the trick.

Preparing the hull. The boat's surface must be thoroughly dry and free from oil impregnation before any kind of overlay fabric is applied. Strip down the hull to bare wood without removing so much of the material that the heads of the fastenings protrude.

Remove all metal hardware and fittings, such as the stem molding and strips on the guard rails. It helps to take off wooden keel strips and splash rails, too.

Don't use a paint remover containing wax. Glass Product Corp.'s "Tuff" paint and varnish remover will do the job you want, as will other commercial preparations available. Don't finish the surface

7 **Before applying the resin,** lay the fabric out on the hull and cut to fit, leaving a generous overlap. You can trim to proper fit later. Roll up the cut-to-size pieces and put them aside.

like a piece of expensive furniture; rather, leave a "tooth in the grain" for more effective bonding.

Fill all holes, digs, and cracks with a non-oil-base hard-setting putty. If paint removers are applied, remove all residues with carbon tetrachloride and wash the hull thoroughly with a solution of ¼ pound of lye to six quarts of water. Hose down with clear water and allow for *thorough* drying before covering.

Lofting the lines. Before preparing the resin, lay out and cut the cloth to fit. With an overage of eight to 12 inches for trimming, cut your fabric to fit the sides, bottom, and transom.

With a helper, I had no difficulty handling bolts of 48-inch width. As a guideline for cutting, with the cloth held rigidly, one strand is plucked clear (much like pulling a thread from loosely woven wool). Then, with a sharp scissors, you can follow the line missing from the weave.

Don't worry about the overage. You'll be able to trim, sandpaper, and/or lap it into the woodwork quite easily. I used thumbtacks to hold the cloth. Put tacks at the keel and/or at the seam of each strake to secure it. You can sheath right over these fastenings.

Apply an initial coating of resin over

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8 Applying the resin and fabric is a two-man job. Attempting it alone can only end in disaster. Spread a generous coat of resin. Be sure the surface is thoroughly covered. Check for dull-looking spots indicating that the thirsty wood has soaked up the resin. Brush more on such spots. Unroll the fabric a little at a time while you work it down tight into the resin. Brush more resin on top of the fabric.

the bare wood, allowing this to soak in—literally satisfying the "thirst" of the wood. Repeat applications in areas that appear to lack resin. A second coating may be applied while the first is wet or dry, although the makers of Boat Armor, the polyester resin we used, recommend the "wet" procedure as providing a more durable lamination.

The fabric must be rolled onto tacky resin and smoothed into place *before it hardens*. A squeegee or grooved roller can be used. Many oldtimers at this boat-covering process use their hands. Keeping a cleanup bucket of Ajax cleanser and water alongside, they periodically scrub their resin-soaked hands like surgeons preparing for a major operation.

Resin technique. Temperature affects curing time. Sixty to 90 degrees F. is possible comfortably; about 75 degrees is an ideal working temperature for handling polyester resins. On damp, humid days or towards evening, curing time is increased because of the moisture in the air. On hot summer days, in direct sunlight, curing sets up faster.

You can provide supplementary heat with workshop heaters. Outside, move into the shade instead of working under a blazing sun. In temperatures under 55 degrees, using prescribed amounts of

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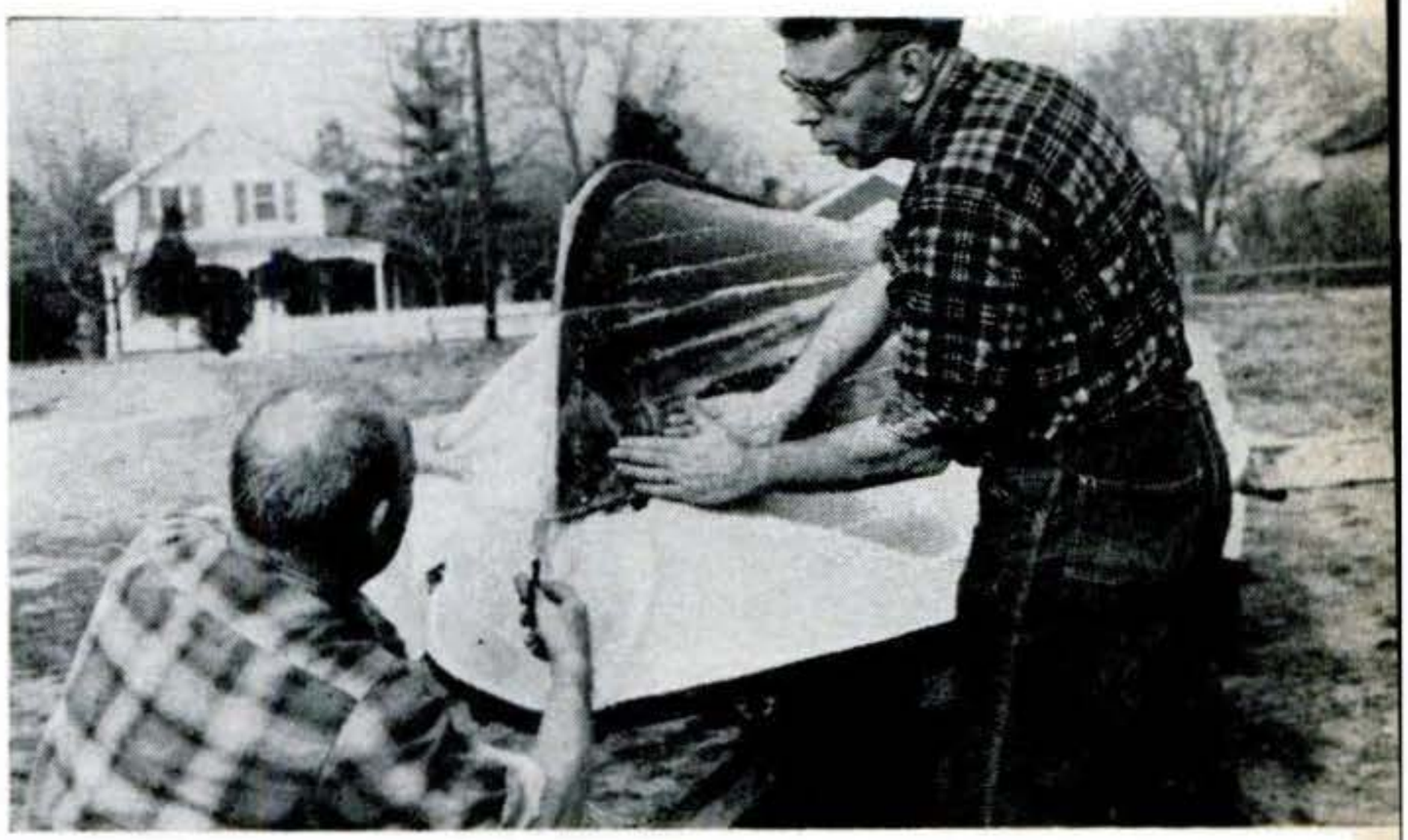


9 Trim the fabric to overlap the bow, carefully smoothing out wrinkles and air bubbles. Cut out gores in the overlap if necessary to make the fabric conform smoothly to the curve of the bow.

10 A permanent weatherproof sheath for flat cabin tops and decks is quickly and easily achieved with Vectra and resin. Its abrasion resistance and flexibility make it durable underfooting.

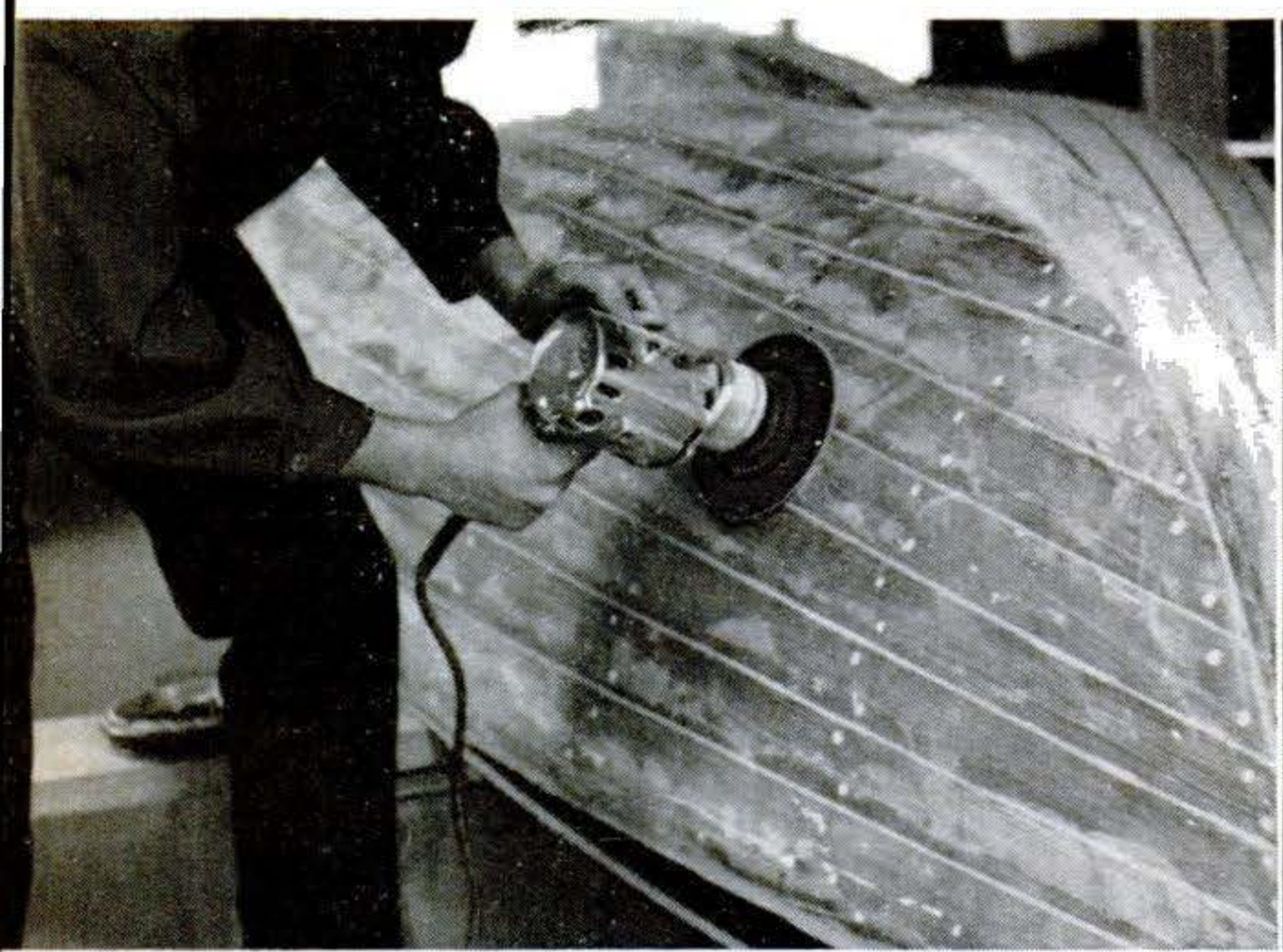
Boat Armor's low-temperature accelerator before adding hardener will help cure the arctic problem. By using approximately half the normal quantity of hardener, you can extend working time in tropical climates.

Mix small quantities of resin so it won't harden prematurely and be wasted. I used about a quart at a time after first mixing smaller amounts as a "test" batch. As a rough rule of thumb, mix only what you can use in 15 to 25 minutes of concentrated working time.

Applying the cloth. Polypropylene is lighter than fiberglass and it must be "worked in" with slightly more pressure to insure a flat surface. Start from the keel. Unroll only a few feet of fabric at a time, one man smoothing the cloth into place while the other saturates it with resin. Work from the top down, pushing the cloth into the lapstrake joints, giving it enough slack or leeway so that extra resin applications will hold it there. Don't let the weight of the cloth pull it away from the hull. Press and work out air bubbles with your fingers as much as possible. It will be necessary to re-do the upper sections (nearer the keel) as you inadvertently work them loose while putting tension on cloth nearer the gunwales.

The botched job I mentioned earlier,

Carvel-planked hull can be finished as slick as molded plastic a



1 Heavy buildup of paint on this hull required an extra-coarse, open-grit sanding disk to cut through to the wood. A second medium-coarse sanding was needed for proper toothed surface.

2 All caulking must be removed from seams of carvel-planked hulls. You can dig and scrape it out by hand, but a carbide blade in a circular saw does a clean job fast on long, full-length seams.

4 Cutting and fitting the fabric is a bit fussier on a round-bottom sailboat hull. But Vectra showed amazing ability to conform to difficult curves. Leave enough fabric for generous overlap at joints.

5 Cut narrow gores where fabric returns across the stem to give a smooth undersurface for the piece covering the near side. Do this after the Vectra has been smoothed into the resin on the far side.

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was what resulted when a man attempted the sheathing operation all alone. The cloth pulled away from each joint, producing a series of air bubbles that were later sliced with a razor blade and filled with resin. The unhappy owner emerged with planks that were covered with Vectra, and joints coated with nothing more than polyester resin. As the hull "worked" in a seaway, it opened up and leaked. *It takes two* to do the job.

Which comes first? I'd start with the transom, since it's straight work that's by far the easiest. With a small piece of fabric, you can perfect your techniques before tackling the lapstrake sides.

I need just as little care

3 Fill open seams with a hard-drying, non-oily putty. We found a stiff mixture of Cab-o-Sil and epoxy resin the most durable and easiest to use. It works like soft butter, sticks like dried barnacles.

6 Completed hull is as slick as molded plastic. The final finish is two coats of Epo-Gloss, a two-part epoxy-acrylic marine paint with porcelain-like gloss and extraordinary adhesion and toughness.

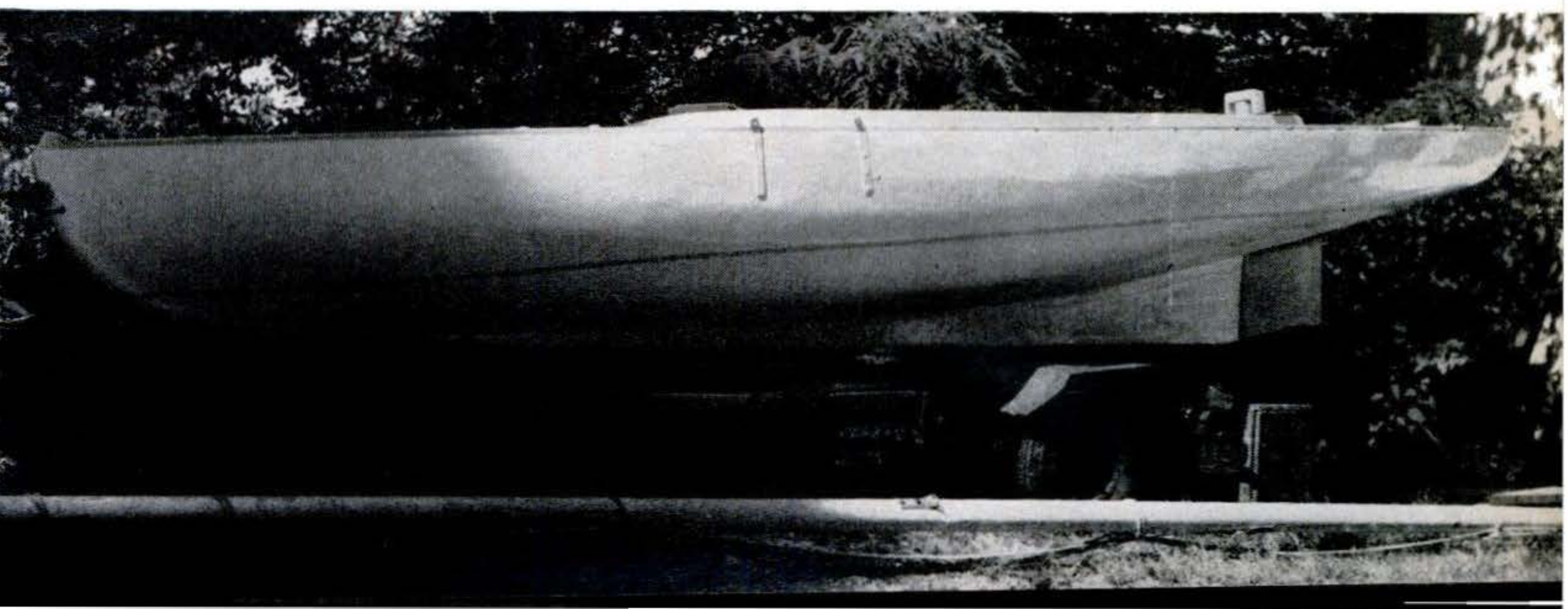
The Vectra should lap over about three inches onto the hull. After eliminating air bubbles and wrinkles, apply an additional coat of resin so that the cloth is saturated from above as well as below. Make a knife slice, and overlap where hull contours cause wrinkles. It won't show later on.

On the bottom, begin at the transom and work toward the bow. Overlap the keel with at least three inches of cloth. Work with about four-foot pieces at a time, using small quantities of resin. Smooth each section before you go to the next. After the fabric is snug, coat the hull with another layer of resin.

The average 16-foot clinker skiff, when used in normal waterways, will require one layer of Vectra polypropylene fabric of a .012-inch gauge, weight 4.30 ounces per square yard, 15-by-15 count, plain weave. Style F-153 is recommended. If the boat is to be subjected to heavy ocean use, such as riding inlets or fishing in the surf, two layers of polypropylene would be better. After sanding, simply apply another coating of resin and repeat the initial process to sheath with another layer of fabric.

When curing is complete, all untrimmed edges should be cut away or sanded. Any overlaps can be faired into the hull's surface. The finished boat can be painted with any good grade of marine paint.

For further information about resins and finishes, write to Glass Plastics Corp., Linden, N.J. 07036, or Fibre Glass-Evercoat Co., 6600 Cornell Rd., Cincinnati 45242. For further details and specific applications of Vectra, write to: The Vectra Co., 350 Fifth Ave., New York City 10001. PS



Blizzard-testing the ne

Starcraf

Brand-new, and very special, this 1968½ trihedral was too hot to hold for '69

With some boats it's a matter of complete trust at first ride. So it was with Starcraft's new Trident TR-16.

I've done my share of operating boats that are just a little bit cranky. They'll skid, or trip, or roll, or wallow. Or a temperamental torque will try to toss you overboard. These are the boats we don't write about in POPULAR SCIENCE. But there are some boats so new, so different, so pleasant, or so practical that we like to bring you an immediate report on them.

This was the case with the new TR-16. So my friend Alan Isley and his col-

leagues skipped a home football game bring the boat to northern Indiana's Lak James.

It was not a great day for boatin For part of the time we were in a r spectable blizzard, and there was sno off and on throughout our test runs. Bu Alan proved to be an all-weather skippe and the TR-16 zipped along as nicely winter as it would in May.

There are 48 models in the 1968 Sta craft line of boats. The Trident TR- becomes number 49. It is the only bo announced in midseason. Basically, th hull is a deep-V design, with longitudin steps. Sponsons have been added at th chine. These carry the chine clear bac to the transom, creating what is termed full chine. As it approaches the transom the chine angles slightly. This produc a softened chine effect throughout the a half of the boat, allowing the boat

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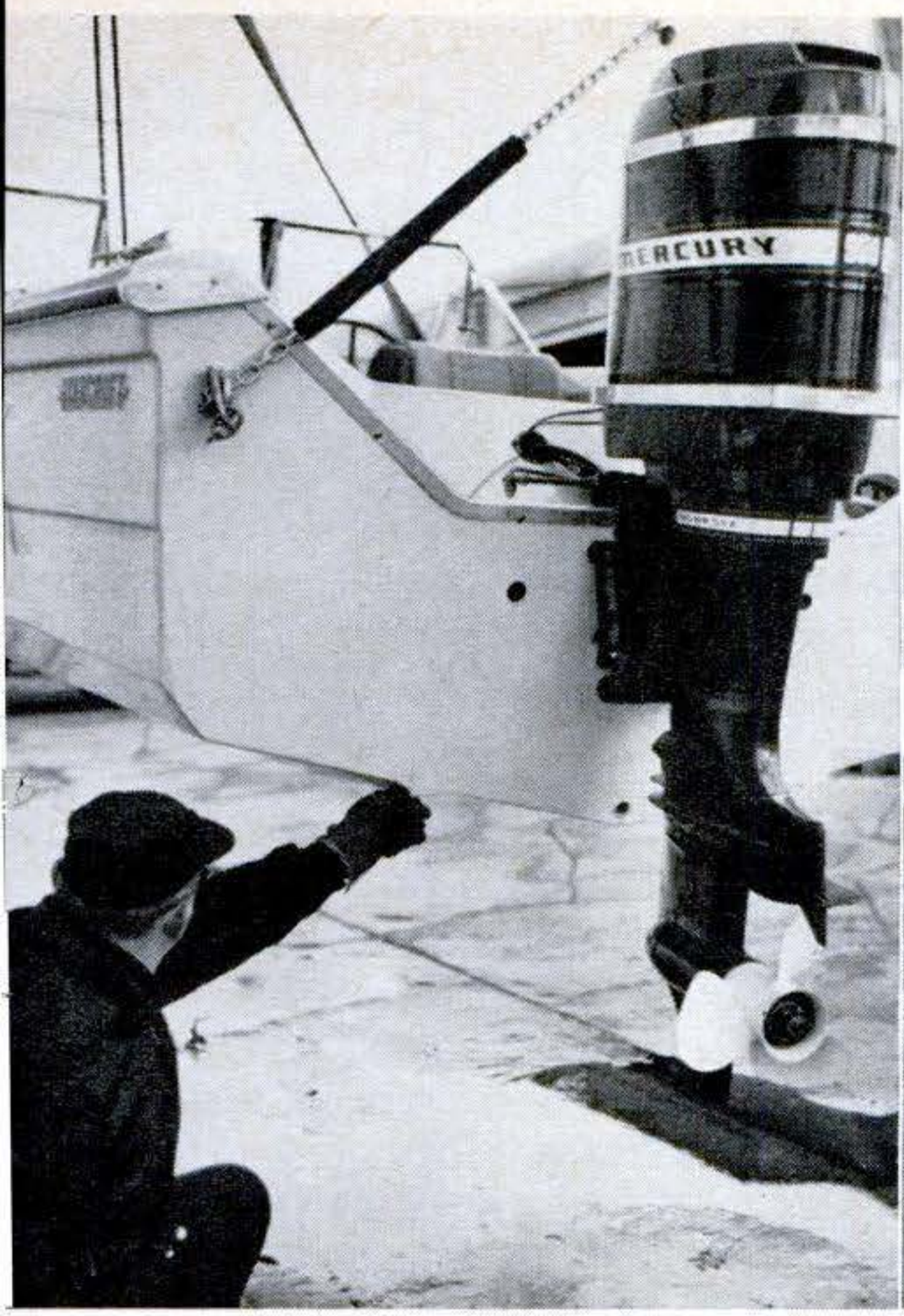

ere may be an icicle or two in evidence, but they n't conceal the handsome lines of the new TR-16, both forward and aft. Hull shape is basically a deep V, with twin sponsons to give stabilization.

ident TR-16

By JIM ROE / *PS Boating Editor*

nk slightly in a turn. This produces a ore normal feel than the extremely flat rn of some trimaran type of hulls. In dition, this softened chine helps pre- nt the boat from catching or tripping on a wake or on choppy waters—a happy-making feature.

Jack Fidler, Starcraft's designer, planned the conformation of the TR-16's hull in a way to give it a very dry ride.

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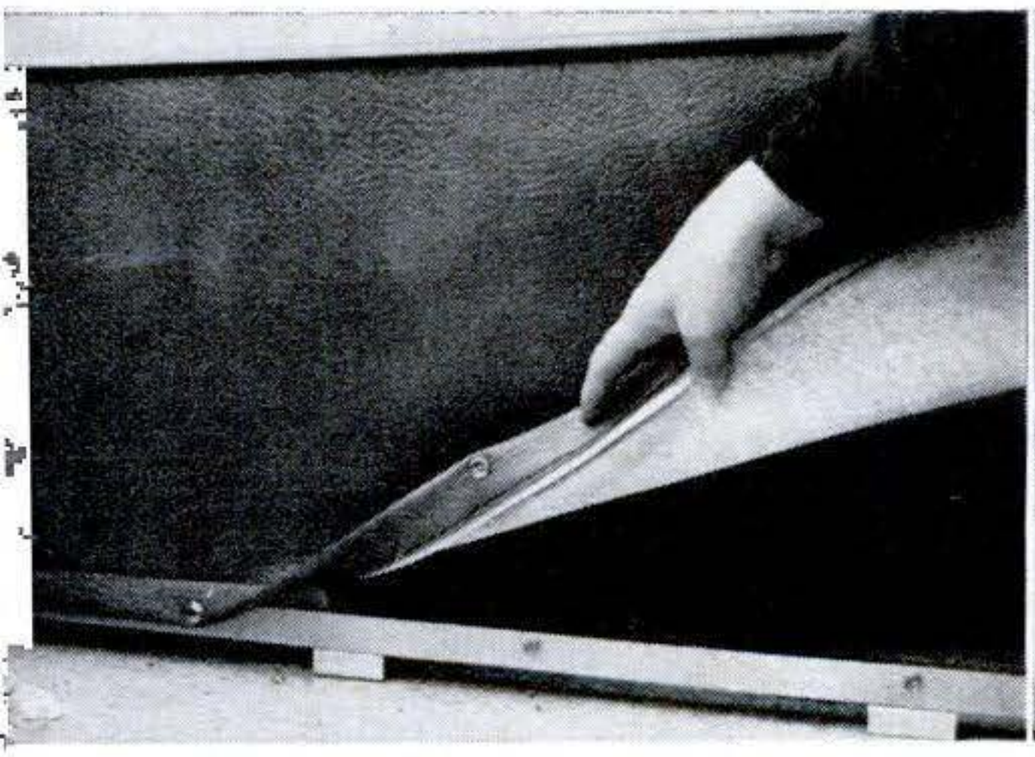
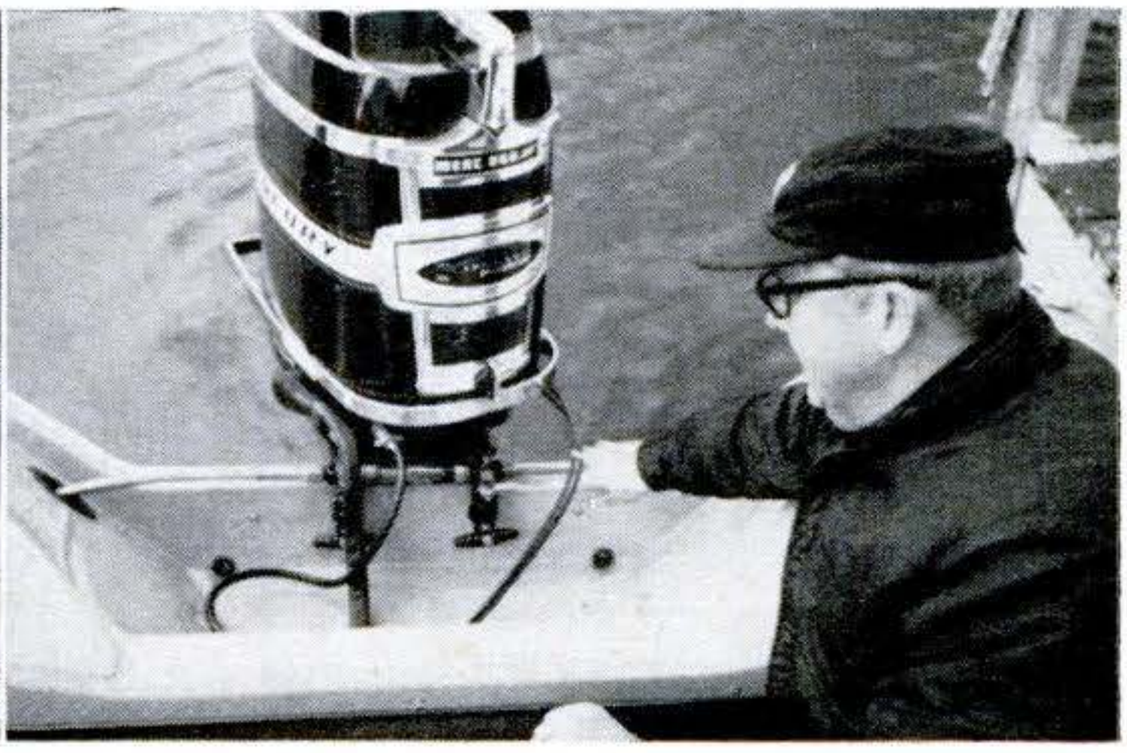


l-area ventilation is provided by gap between ttom of transom flap and deck. Also, air can cir- late freely at each end of the flap. The flap un- aps to permit removal of tanks for fueling.



Mercury outboard of 95 hp. powered our POPULAR SCIENCE test boat. We hit speeds of 40 m.p.h. The 16-foot Trident carries a maximum horsepower rating of 100, a maximum load rating of 1,400 pounds.

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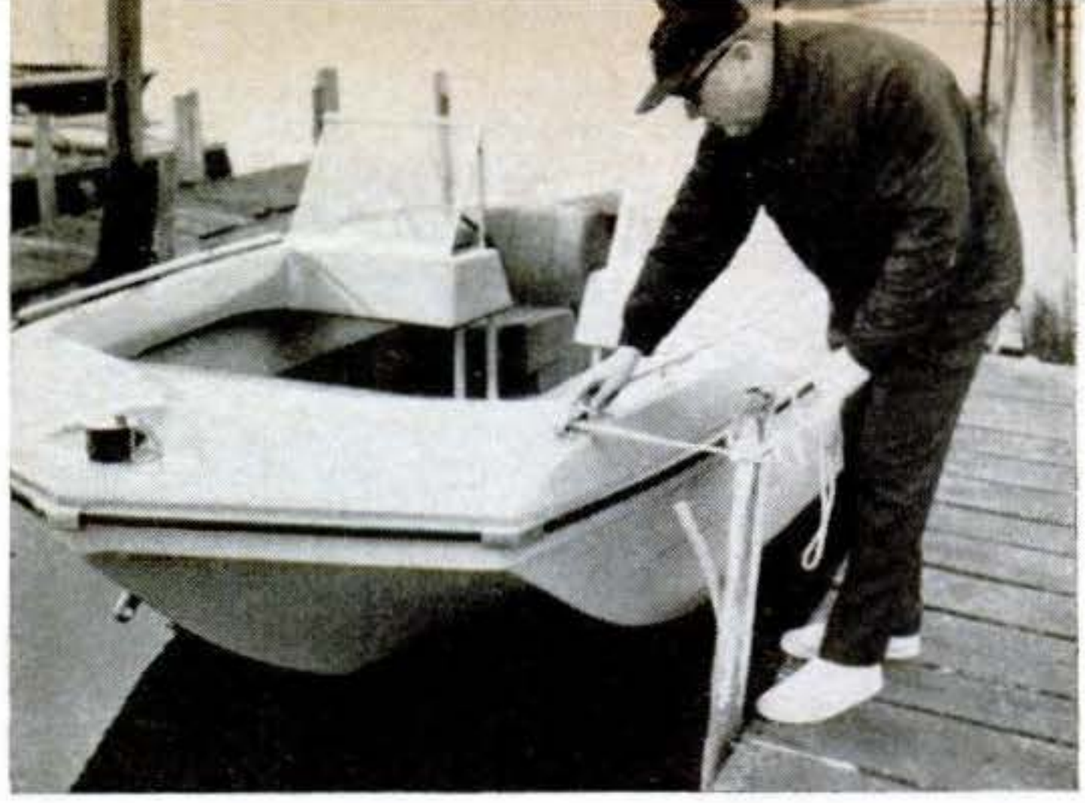
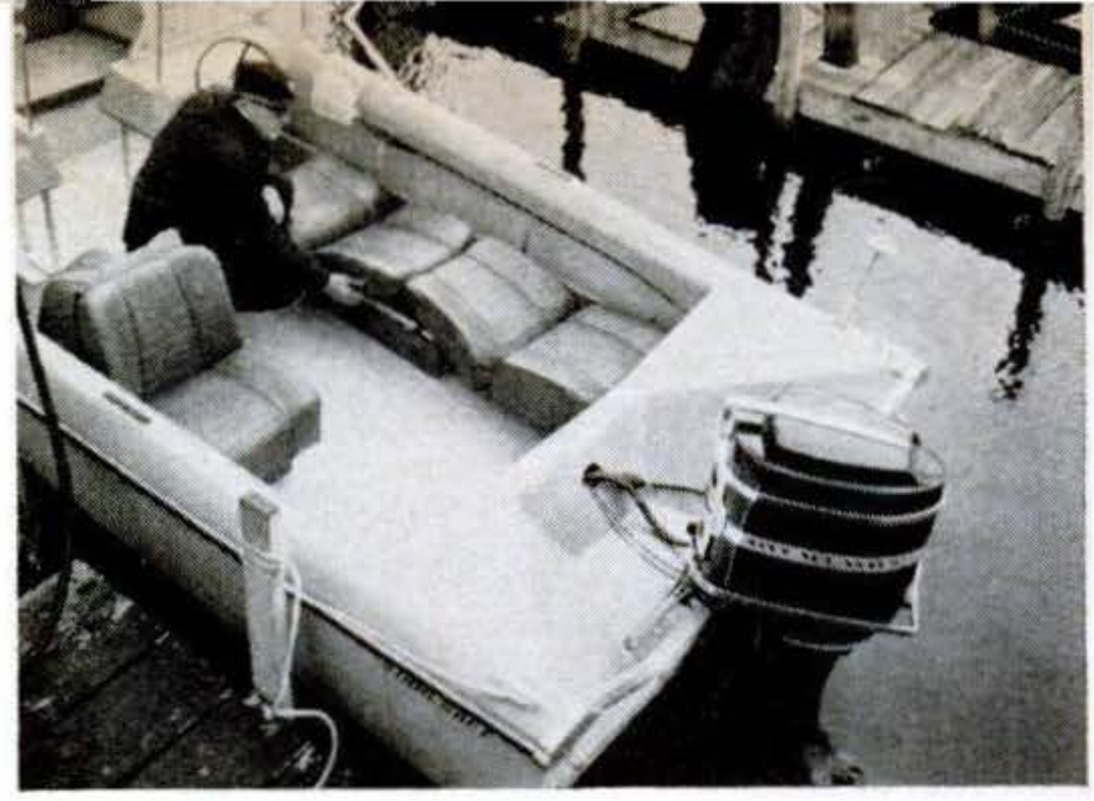
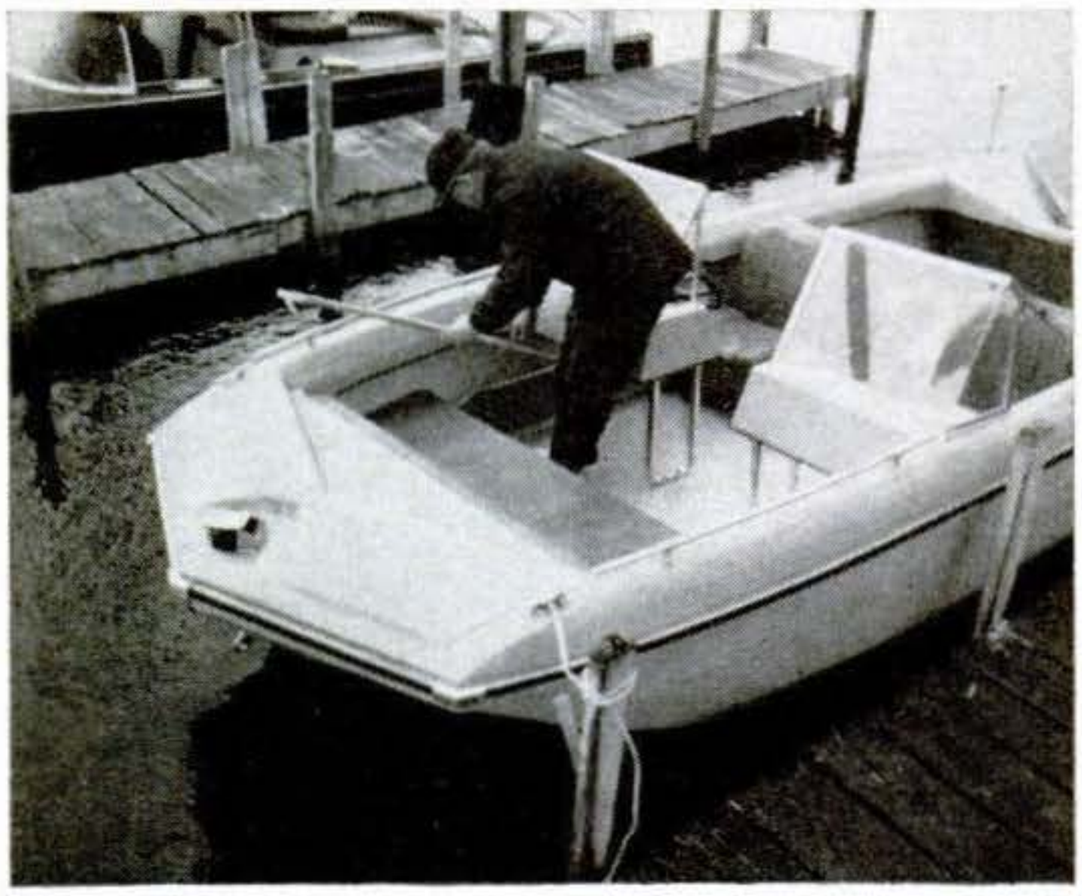


Bow mooring cleats are located on each side, at the gunwale—much easier to reach than a single center-mounted cleat. Big, bow-rider area is convenient for fishing, also a fine spot for a joyride.



Cockpit aft of the steering station is unusually spacious. It's uncluttered, allowing plenty of room for fishing, skiing, or scuba gear. Fold-up seats convert to sunbathing lounge, as Jim Roe demonstrates.



Built-in storage bins beneath each gunwale provide ample room for water skis, long boat hooks, other miscellaneous gear. Walk-through divided windshield gives easy access to bow-riding area.

STARCRAFT TRIDENT SPECIFICATIONS

Centerline length	16′ 1″
Gunwale length	18′ 2″
Beam	81″
Bow depth	41″
Center depth	41″
Transom width	72″
Transom height	21″

On our test day I was happy to find Jack had planned well. In spite of many high-speed maneuvers, I never once received water in the face. Most of the spray is turned down at the chine, or is contained under the boat. The TR-16 also features a clean-lined transom that minimizes wake and produces a clean run astern.

And it's a speedster, in addition to its roominess and stability. Our test boat was equipped with a 95-hp. Mercury outboard. This gave us right-now pickup and satisfyingly high top speed. I estimated we hit better than 40 m.p.h.

In controlled conditions, Kiekhaefer engineers have tested this hull with both 50- and 65-hp. outboards. The 65 Merc drove it at 33.4 m.p.h. with one person aboard and a resultant gross weight of 1,282 pounds. With four aboard and a gross weight of 1,732 pounds, top speed was 31.1 m.p.h. With a 50-hp. outboard, speed was reduced by about three m.p.h.

Every test successful. At any speed, I found the Trident TR-16 a trustworthy and satisfactory hull. During the first few minutes this boat gave me the feeling that it was going to do everything well, and proceeded to live up to that promise.

And it is a tough, take-care-of-itself boat. Starcraft's Bud Sanxter gave me this word picture of what's behind the gelcoat and beneath the floorboards:

"The Trident has a two-by-six-inch oak center keel. There are transverse stringers on 24-inch centers, and four longitudinal stringers in addition to the center keel. We use isothalic resins and gelcoat, because a more even temperature control during the curing stage reduces shrinking. Also, the isothalic gelcoat is more flexible; this reduces the occurrence of surface fractures due to impact. The bottom of the hull is five layers thick. This measures 3/8 inch, plus an additional layer at the keel. Total thickness at the keel itself is about a half-inch of tough fiberglass."

I think when you see her you'll like the Trident TR-16. PS

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Russian jet transport is on New York-Moscow shuttle

This four-jet Ilyushin IL-62 is becoming a familiar sight at New York's Kennedy airport. Russian-built, it shuttles between New York and Moscow on a reciprocal agreement between the U.S. and USSR, which also makes Pan Am's jets familiar to Muscovites. The IL-62, with engines of 23,000 pounds' thrust each, carries 186 passengers. Planes of both nations fly the 4,660 miles eastbound in nine hours, 10 minutes, westbound against prevailing winds in an hour longer. Off-season roundtrip excursion fare: $548.

Color-TV camera weighs only 44 pounds

You'll be getting the sights and sounds of the national political conventions this summer through portable color-TV cameras like the one at right. With the backpack, it weighs only 44 pounds. It's made by Norelco, and marketed by Philips Broadcast Equipment Corp., Paramus, N.J.

Is it a boat, or plane, or ACV?

Bernhard Schwarz of Splugen, Switzerland, was not satisfied to build a boat, or a plane, or an air-cushion vehicle. He combined all three. Capable of 62 m.p.h., it's driven by a 40-hp. VW engine. Wing and air cushion begin lifting it at 30 m.p.h. At 50, it becomes a plane.

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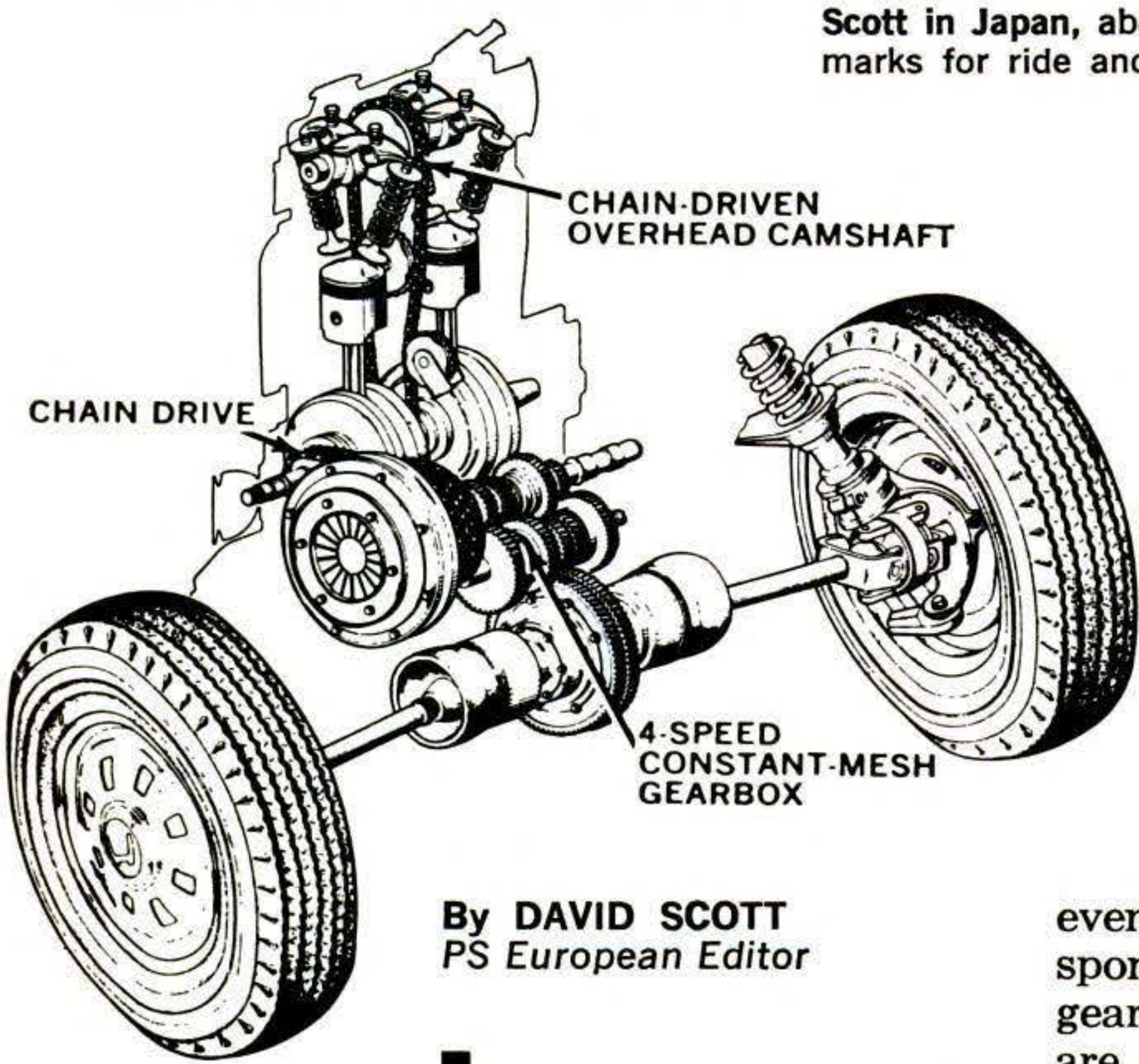
Scott in Japan, about to test-drive the Honda 600. He gave it good marks for ride and handling but criticized it for engine noise.



Engine and transmission are set across the car, driving the front wheels. Gearbox input shaft is chain-driven at reduced speed from crankshaft; the countershaft is geared to the differential. Overhead camshaft is also chain-driven, and hemihead valves are splayed at about 60-degree angle.

Miniature masterpiece!

By **DAVID SCOTT**
PS European Editor

If you don't mind the racket, the tiny Honda 600 makes a delightful suburban gadabout, fun car, or mobile shopping basket with a sensationally low price tag.

The machine I tested in Japan sprinted with a lusty scream from 0-60 in 17.5 seconds. This zip comes from an easy-breathing overhead-cam twin that delivers maximum torque way up between 5,000 and 6,000 r.p.m., then howls to 7,000 for peak power.

The steering is ultralight, though a bit vague. It corners in the best front-wheel-drive fashion, with little roll and no tail-slide. Brakes stop the car firmly and evenly, although the pedal feels a little spongy. Shifts in the constant-mesh gearbox are smooth, but since the gears are engaged by dogs instead of synchro-mesh, you can't hurry the shifts.

Interior space is remarkable, considering the skimpy outside dimensions. Up front a six-footer gets two inches of extra head room—though for maximum leg room in front, the back seat is best left for kids. The shift lever is hung under the dash, and the floor is flat and unobstructed. Standard equipment includes two-speed wipers, undersealing, backup lights, bolt-on easy-repair fenders, and a cunning gas cap that unlocks from the driver's seat. It's a real economy car, giving about 40 miles to the gallon. Motorcycle buffs should go for it, and plenty of others, too.

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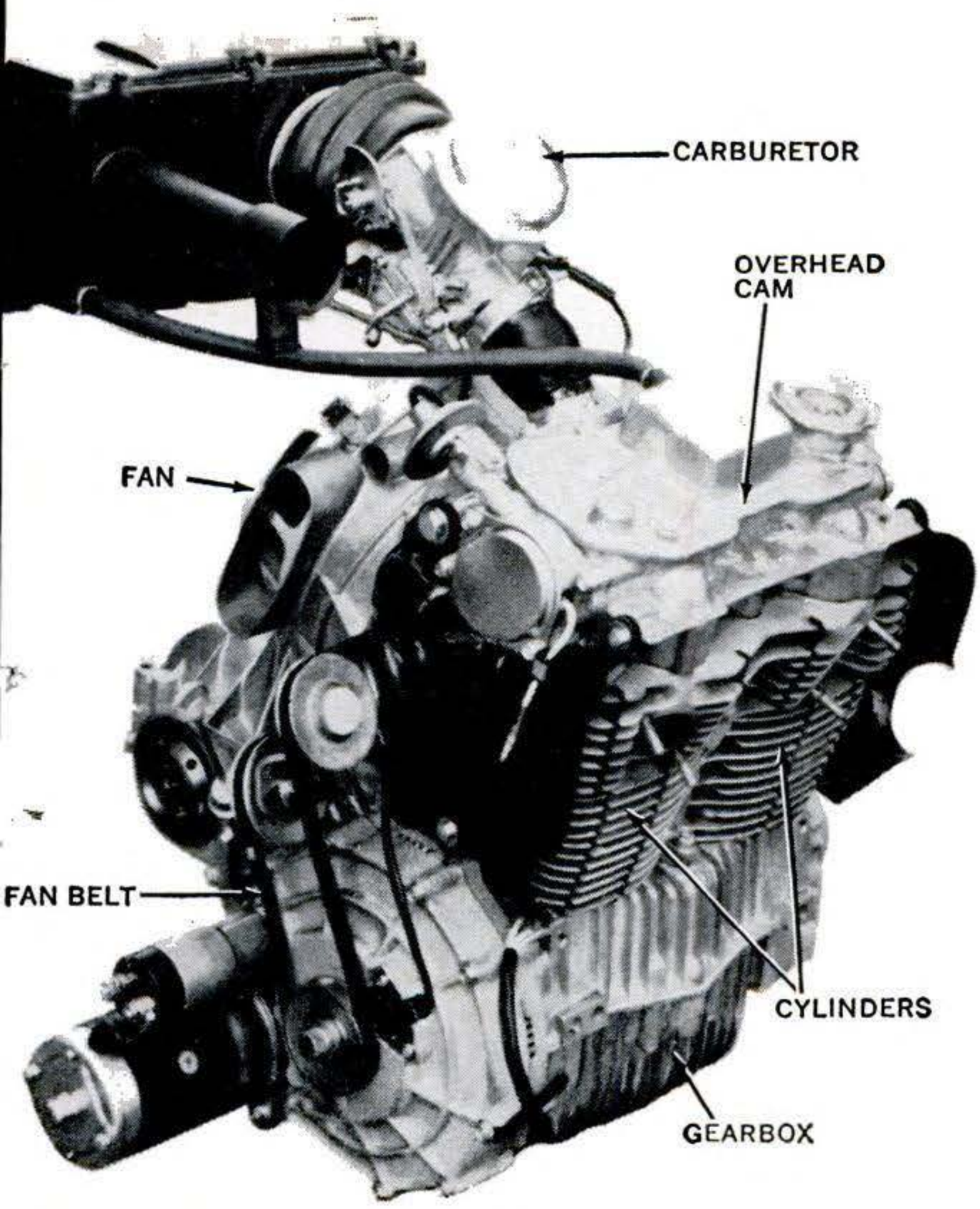

Air-cooled parallel-twin looks as if it's meant for a motorcycle, but it drives this minicar to a top speed of 80 m.p.h.

Tightly packed engine compartment also houses battery and spare wheel. The power unit is cooled partly by axial-flow fan and partly by ram air.

Honda shows off, displaying its usable trunk—something few minicars can boast. The rear seat is movable to increase trunk space as needed.

HONDA 600

Scott found ample head room for tall drivers and plenty of leg room, too. Interior is uncluttered.

DIMENSIONS (inches)

Wheelbase	78.8
Front track	44.3
Rear track	43.3
Length	120.9
Width	51
Height	52

ENGINE

Type	OHC parallel-twin
Displacement	36.5 cu. in.
Bore & stroke	2.91 x 2.74 in.
Compression ratio	8.5:1
Horsepower @ r.p.m.	45 @ 7,000
Torque @ r.p.m.	40 @ 5,000

CHASSIS

Transmission	Manual 4-speed
Tires	5.20-10
Turning diameter	28.9 ft.
Steering ratio	17.4:1
Brakes	Drums all around
Suspension, front	MacPherson system with coil springs
Suspension, rear	I-beam axle/semi-elliptic leaf springs
Curb weight	1,213 lb.
Price	$1,275 (POE West Coast)

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PS ELECTRONICS

A Balance/Phase Meter for Your Stereo Set

By RONALD M. BENREY / *PS Electronics Editor*

This easy-to-build electronic test instrument helps to keep y

In less than 10 seconds flat, this handy triple-purpose test meter can verify that your stereo set is hooked up properly and adjusted for optimum performance.

- As a *phase meter,* the instrument verifies that the two speakers are connected in phase, which means that the voice coils move in step with each other. This is important since out-of-phase speakers make an empty, washed-out sound because the out-of-phase waves they produce partially cancel each other out.
- As a *balance meter,* the instrument helps you adjust your stereo amplifier's balance control to assure equal sound output from both channels. This is necessary so that you hear the reproduced music with correct perspective.
- As an *audio-output signal-strength meter,* the device lets you check out the frequency response of your amplifier, when used in conjunction with the 1968 PS stereo test record (see PS Feb. '68 and box at right).

How it works. The heart of the instrument is a tiny integrated circuit (see diagrams on page 128) that functions as a differential amplifier. This is a unusual circuit that electronically subtracts one signal from another. Its output is proportional to the difference between the signals. Thus, if the two sig

Here's how to get your copy of this exciting 1968 PS test record

When the Project 3 POPULAR SCIENCE Stereo Test Record goes on sale in record shops, its suggested retail price will be $5.79—a price that reflects the care with which it is made, and the quality of materials used.

You can order it now, by mail, for the special PS reader's price of $2.98 (postpaid). Send a check or money order, and the coupon below, to: Stereo Test Record, Project 3, 1270 Avenue of the Americas, NYC 10020.

Name.....

Address.....

City.....

State.....**Zip**.....

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·eo hi-fi adjusted for optimum performance

als are identical, the difference is zero. The level of the difference signal, if any, ; indicated on the audio volume unit or VU) meter, M.

The signals that the amplifier works with are generated by two permanent-magnet loudspeakers—one inside the main instrument case, the other in the smaller outrigger box. Here, the two loudspeakers double as inexpensive dy-

Continued

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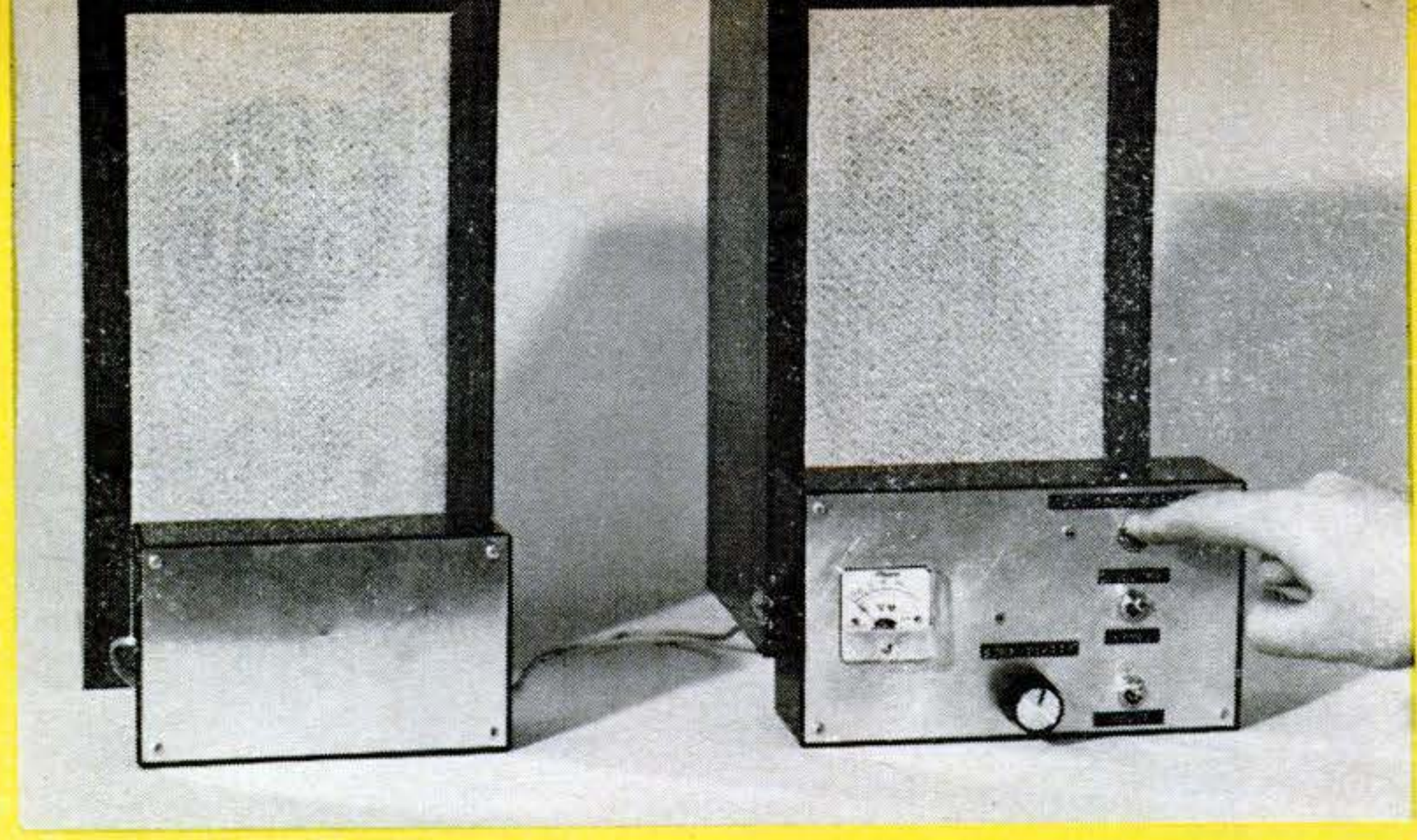
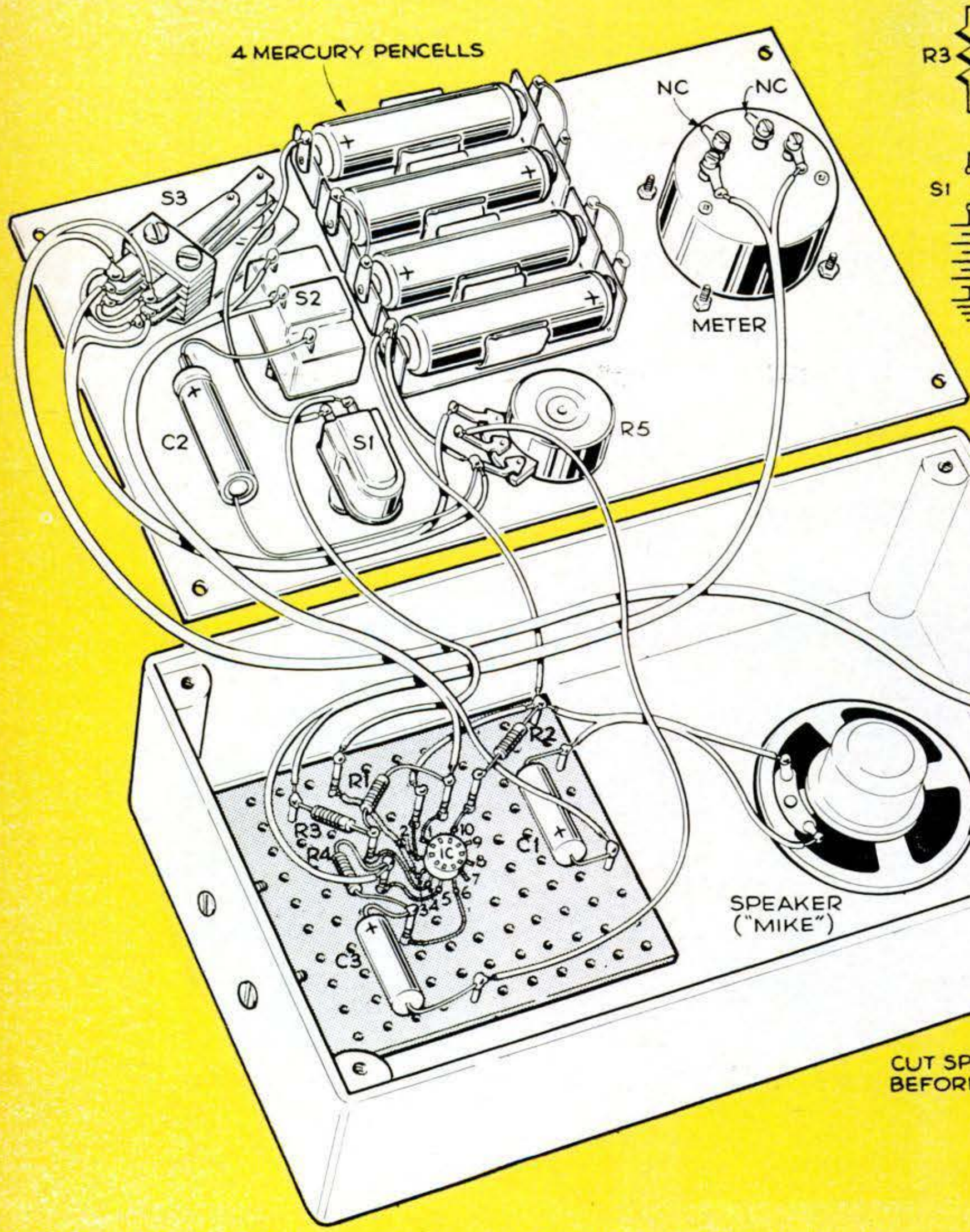
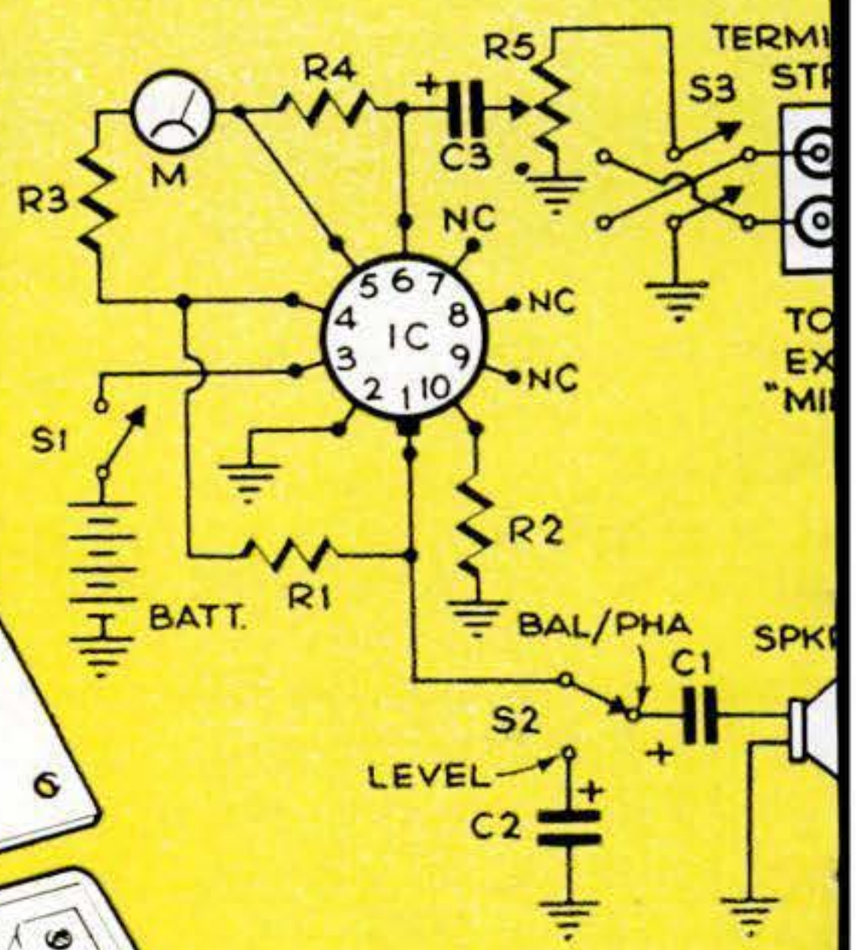


PARTS LIST

R1, R4—47,000-ohm, ½-watt, carbon resistor
R2—47-ohm, ½-watt, carbon resistor
R3—1,000-ohm, ½-watt, carbon resistor
R5—5,000-ohm potentiometer
C1, C2, C3—100-mfd., 10-volt electrolytic capacitors
S1—SPST toggle switch
S2—SPDT toggle switch
S3—DPDT pushbutton switch
IC—Motorola HEP-556
Misc.—Miniature 8-ohm loudspeakers; bakelite instrument cases; battery holder; perforated chassis board; push-in terminals; VU meter (Lafayette #99H5024)

For phasing test, position the main chassis and outrigger mike in front of the speakers. Press, and then release, the pushbutton switch and note before and after meter readings. See text for how to interpret test results.





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amic microphones ("mikes" hereafter). When function switch S2 is in the al/Pha position, the output of each ike is fed to one of the amplifier's in-uts—but there is an additional compli-ation: Normally, the two mikes are con-ected in phase to the circuit—that is, e same terminal of each unit is con-ected to ground, and to its respective mplifier input. When pushbutton switch 3, however, is pressed, the leads to the utrigger mike are reversed, throwing the vo units out of phase.

To test for proper speaker phasing, ou set up the units a foot or so in front your speakers as shown in the photo left, and set your amplifier for monau-l at moderate volume. Your test signal n be the phasing-test band on the PS st record, or a musical selection on an-her record. Then you press and re-ase the pushbutton switch, while you atch the VU meter: If the meter reads lower value when the button is pressed, en you know the speakers are wired ut of phase. To correct this, reverse the ads to *either* speaker—not to both.

Once speaker phasing is verified, you n adjust channel balance. The test tup is the same as above, except that ou must be sure to position the two ack boxes an equal distance from each peaker (about two feet is a good dis-nce). Now adjust the amp balance ontrol for a minimum reading on the anel meter.

Note: For both the above tests, the instrument's "sensitivity" control, R5, should be set to maximum (full clockwise rotation).

To use the device as an audio-output-level meter, flip switch S2 to "level" and replace the outrigger mike with a set of test leads equipped with alligator clips on their ends. Hook the clips across the terminals of either speaker.

This function of the instrument is designed especially to help you use the frequency-response test tones recorded on the PS test record. With the amplifier set for stereo reproduction and normal listening levels, adjust the test meter's sensitivity control for a midscale reading on the meter. Then, as the different frequency tones—from 30 Hz to 10,000 Hz—are played, you can gauge your system's frequency response by watching the meter needle.

Building it. The two black boxes are aluminum-paneled Bakelite instrument cases available from Lafayette Radio, Syosset, N.Y. Mount the IC and its associated components on a piece of perforated phenolic chassis board; use push-in terminals as wiring points. Be sure you observe correct polarity when you mount the electrolytic capacitators.

Use color-coded speaker cable (one gold- and one silver-colored conductor) to connect the outrigger mike to the main case. This will insure that the speaker/mikes are properly phased. PS

alance test. Position the two black boxes in front the speakers (shown closer together than usual, ove, for clarity) with their mike cones aimed at the speakers. The boxes must be equidistant from the front of the enclosures. Adjust the amplifier balance control for minimum meter deflection.

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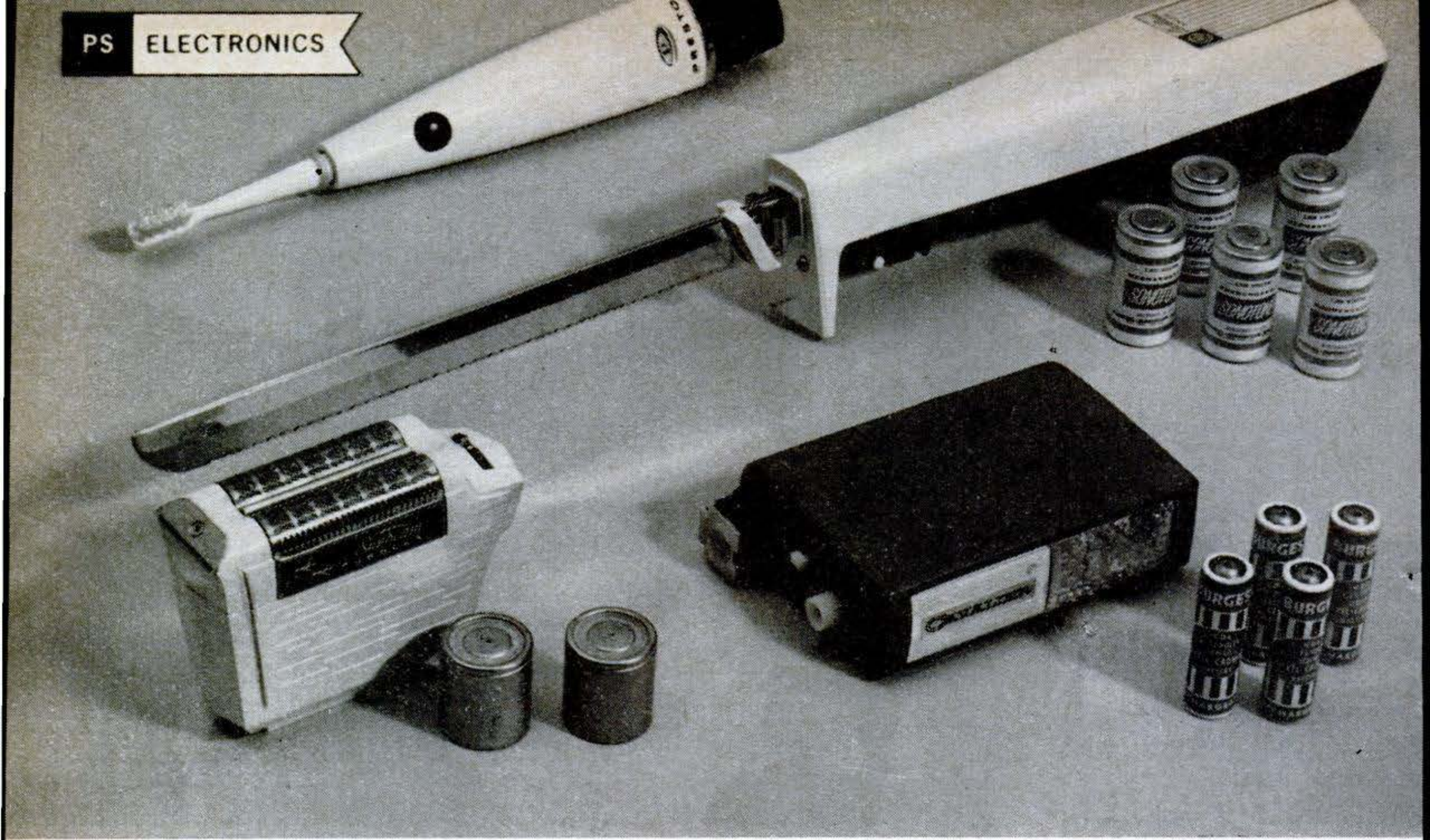


IT'S EASY TO Service Your Ni-Cad

By **RONALD M. BENREY**
PS Electronics Editor

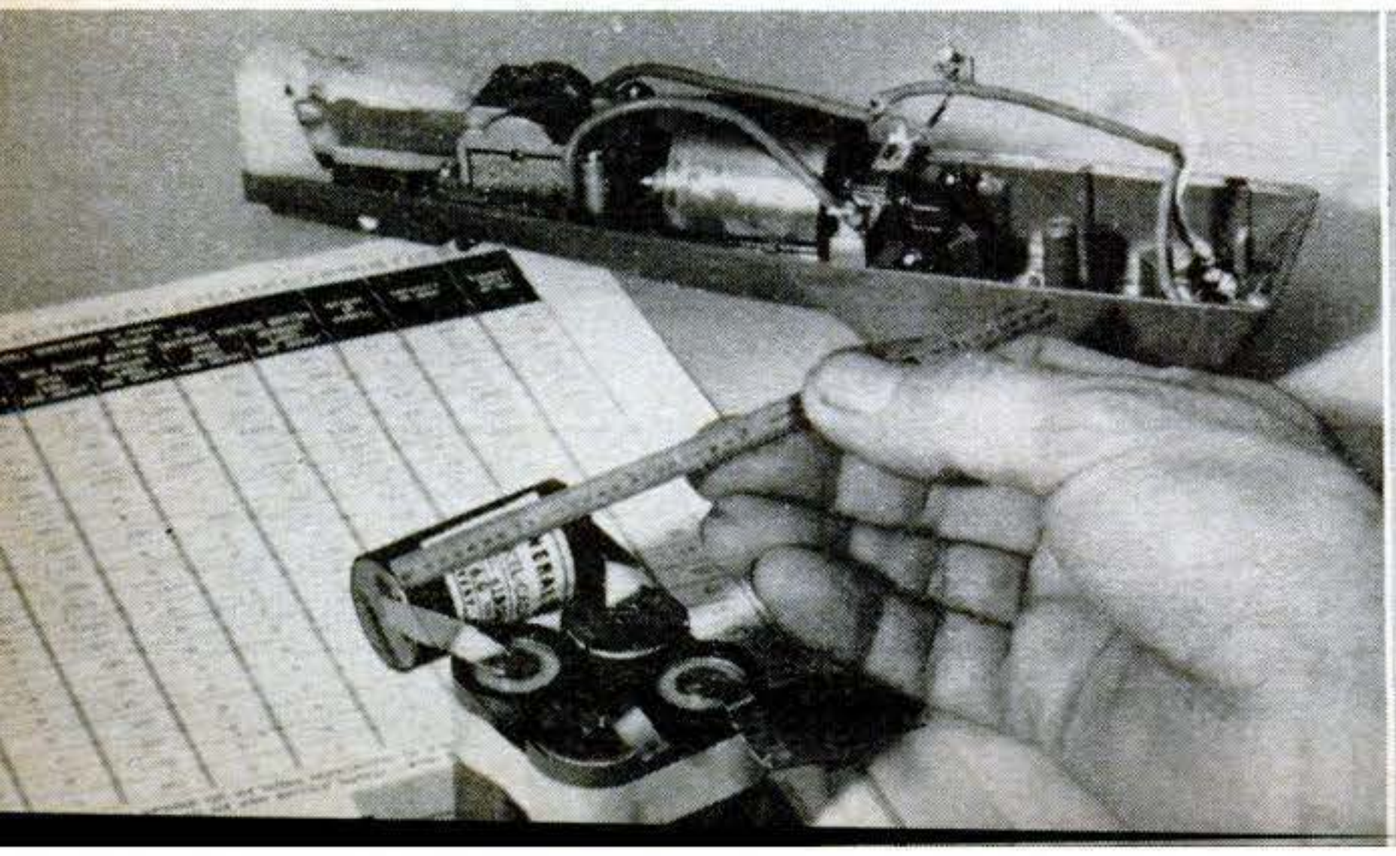
That ubiquitous package of portable power—the nickel-cadmium (or ni-cad) rechargeable cell—is a remarkably long-lived device. Given proper care, a set will outlast the appliance it's built into.

Rule 1. Avoid discharging the cells completely. When the appliance starts to slow down, pop it into the recharger.

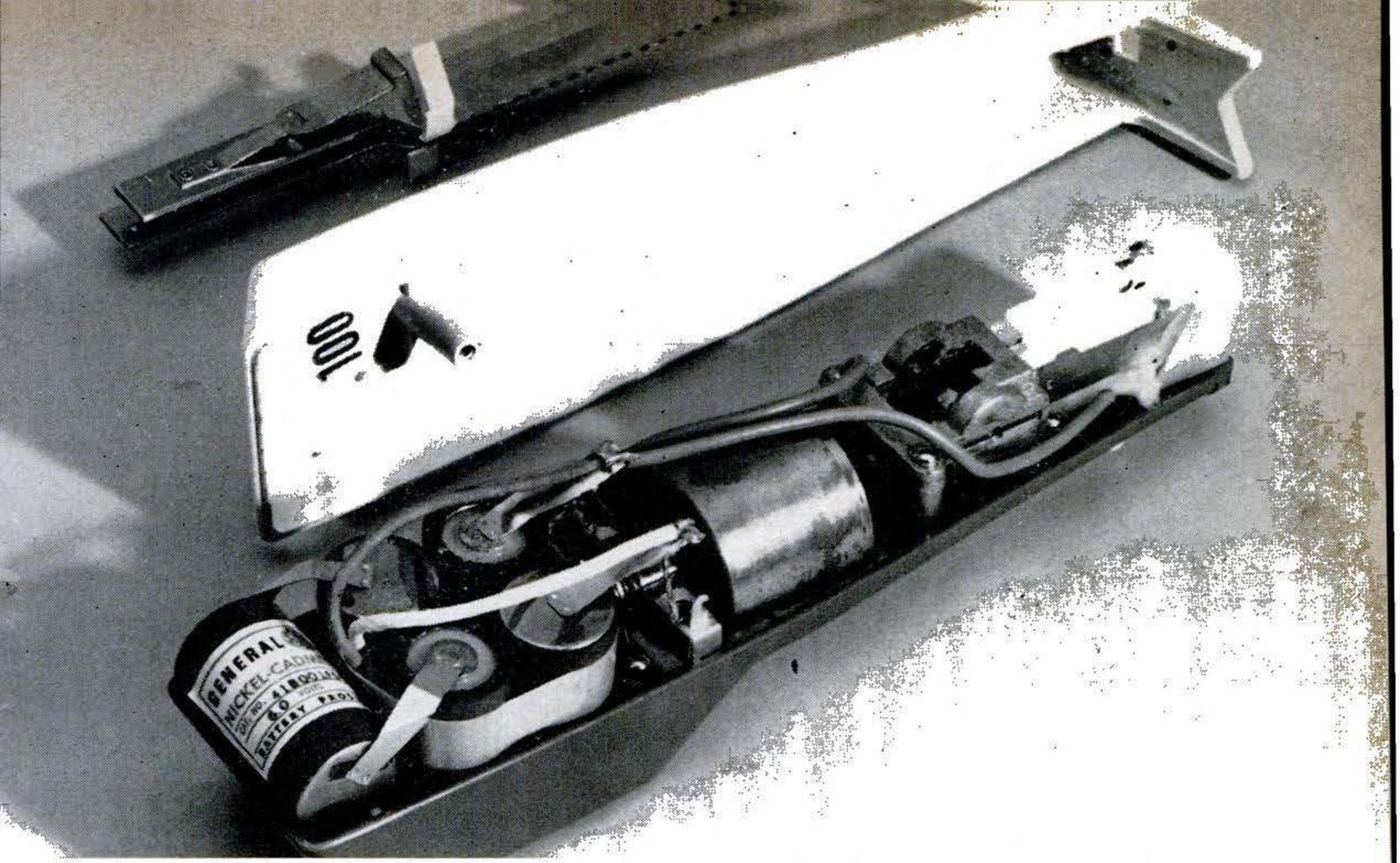
Rule 2. Always recharge a ni-cad-powered appliance in a cool spot. High temperatures can cause the cells to accept an overcharge, which may damage them.

Rule 3. Keep the appliance in the charger even though the cells are fully charged, and even if you aren't going to use the appliance for a long time. This

1 Unsolder pack from appliance wiring, keeping track of which lead goes where; draw a simple wiring diagram. Cross-checking catalogue locates Sonotone cells that will replace the originals.



2 Tin top and bottom contacts of new cells with rosin-core solder. Heat the surfaces and let a blob of solder flow on. Then whisk away excess with a wire brush, leaving a thin solder film.



A popular-ni-cad-powered carving knife is our test patient in the photos on these pages. Separating knife's plastic handle halves reveals the battery pack: a side-by-side group of five ni-cad cells.

Household Helpers

is called continuous trickle charging, and is recommended by ni-cad manufacturers (it uses only a few pennies of current per year). An exception to this rule: If the charger is designed for fast charging rather than conventional slow charging (charge times of 10 to 16 hours) follow the manufacturer's recommendations.

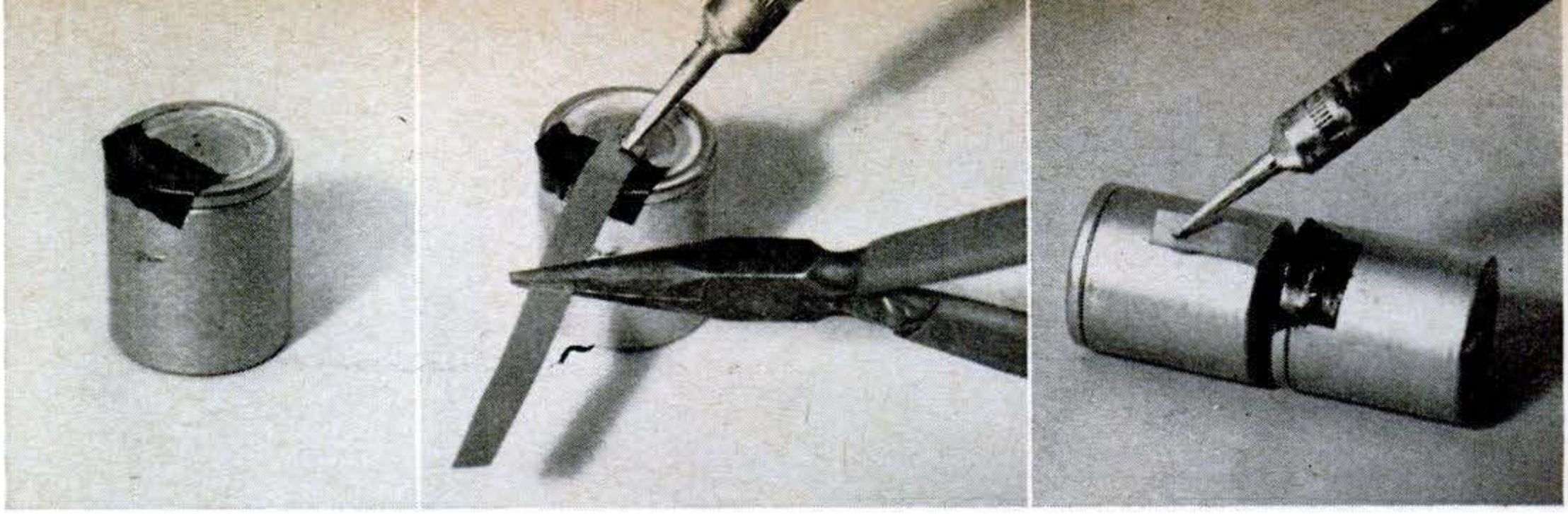
Should a set of ni-cads fail, replacing them is usually an easy job—if you can get the appliance open. However, many inexpensive ni-cad-powered products—including virtually all electric toothbrushes—are sealed at the factory. You can't fix these yourself.

The simple steps in replacing a ni-cad battery pack are outlined in the photos on these pages. But before you reach for your tools, I'll give you a tip that could save you money.

Continued

3 Tin connecting links, hold each link on appropriate terminal (use pliers), and touch top with iron; the two tinned surfaces will fuse together. Completed pack is a replica of original.

4 Mount new pack in appliance, and solder internal wiring lead to the two end connecting links. Be sure to observe correct polarity; appliance won't work if battery is wired in backwards.



End-to-end connections are easy to make, if you insulate the top surface of the lower cell with a piece of plastic tape (above, left). Next, solder the connecting link to its positive button, as usual (center). Finally, bend the link so it wraps around case of upper cell, and solder it to the case (right). Carry out same procedure repeatedly to build a battery containing more than two cells.

If you open a faulty ni-cad-powered appliance and find the cells covered with a white residue, you can be sure that one or more of the cells leaked some of their potassium hydroxide electrolyte and short-circuited the pack—a common type of cell failure.

A leak isn't always fatal, however. Remove the battery and carefully rinse away the residue with water. Replace the cells, and try to recharge them. The chances are good that, in spite of the leakage, the cells still contain enough electrolyte to work normally.

How to replace ni-cad cells. In some devices, such as the electronic photo-flash unit pictured on page 130, the group of ni-cad cells are mounted in clip-type cell holders; to replace them, just pop them out and slip in a new set.

In most appliances, though, the cells making up the battery pack are spot-welded to metal connecting links, which are in turn soldered to the appliance wiring. To replace the pack you must build a new battery out of loose ni-cad cells. Happily, soldering will hold them together as well as spot-welding.

Start by removing the old battery from the appliance. Note that the ni-cad cells in all appliances are wired in series, and that the case of every cell is its negative terminal, while the central button on its top surface is the positive terminal.

Measure the individual cell size, and compare dimensions with the specification chart in a ni-cad-cell catalogue to determine the cell type used. I got my catalogue from the Sonotone Corp., Elmsford, N. Y. 10523.

Don't be distrubed if you can't match cell size exactly: Cells from different manufacturers often vary in size slightly and small dimension differences (within 10 percent or so) won't affect electrical performance. Be sure, though, that the cells you choose will fit inside your appliance.

The thin (.010-inch) metal strip used to interconnect the cells must be cut from either pure nickel sheet or nickel-plated steel—the latter is available at most large hardware and sheet-metal shops. Other metals may react electrolytically with the cell's nickel case and cause corrosion. Or you can carefully break the spot welds that hold the connecting strips on the faulty battery, and re-use them.

Soldering a connecting link in place is very simple if you tin both the strip and the cell terminal first. It helps to burnish the cell terminals with a fine file, prior to tinning, to clean the surface and roughen it slightly.

Be sure to use low-melting-point (67 percent tin, 33 percent lead) rosin-core solder that is intended for electronic wiring. Work as quickly as possible, with a hot iron so that you avoid overheating the cell. Be especially careful when you solder to the positive button—too much heat can melt its nylon insulator.

In-line-cell batteries. These, shown in photos above, are a bit more complicated to duplicate than the side-by-side pack shown on the previous page.

Because you must remove each cell's insulating jacket, you have the problem of preventing the connecting link—which must bend around the upper battery—from short-circuiting the positive button and case of the lower battery. The solution is a piece of plastic electrical tape on the edge of the lower battery, to separate its case from the connecting link. PS

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This month's question for the Ask-Our-Computer service

What's the Right-Size Central Air Conditioner for My Home?

Hot weather's on the way, so now's the time to make your plans. Our computer can help

In spite of what your thermometer says, winter is almost over. And spring is the logical time to start thinking about central air conditioning—if you want to have your system ready-to-cool when the first blistering days of summer arrive.

Because a central-air-conditioning unit is no small investment, we've written a program for our giant electronic brain to help you with your planning. It's called COOL, and although it won't plan the perfect system for your home—only a reputable air-conditioning contractor can do that—it will give you a good idea of the size of the system you'll need. Here's how it works:

Send us a stamped, self-addressed envelope and we'll mail you a detailed questionnaire that asks many specific questions about your home, such as exterior wall area, window area, and the summer design temperature in your area.

When you return the completed questionnaire to us, along with a two-dollar service fee, our programers will feed the data into the computer.

COOL analyzes your home's air-conditioning requirements and comes up with an estimate of the tonnage rating of the cooling system you'll need.

And then the computer goes one step further: It uses the data you supplied to estimate the effectiveness of your home's present insulation. Working with this estimate, the machine calculates how your air-conditioning requirements would change should you add extra insulation at the same time the air conditioner is installed.

You will receive the actual computer-produced answer sheet that contains all of these estimates and calculations.

Send your stamped, self-addressed envelope (legal size) to Ask-Our-Computer, Program #9, POPULAR SCIENCE, 355 Lexington Avenue, NYC 10017.

If you have any suggestions for problems that would make suitable Ask-Our-Computer programs, write them on a postcard, and mail to Ronald M. Benrey, Electronics Editor.

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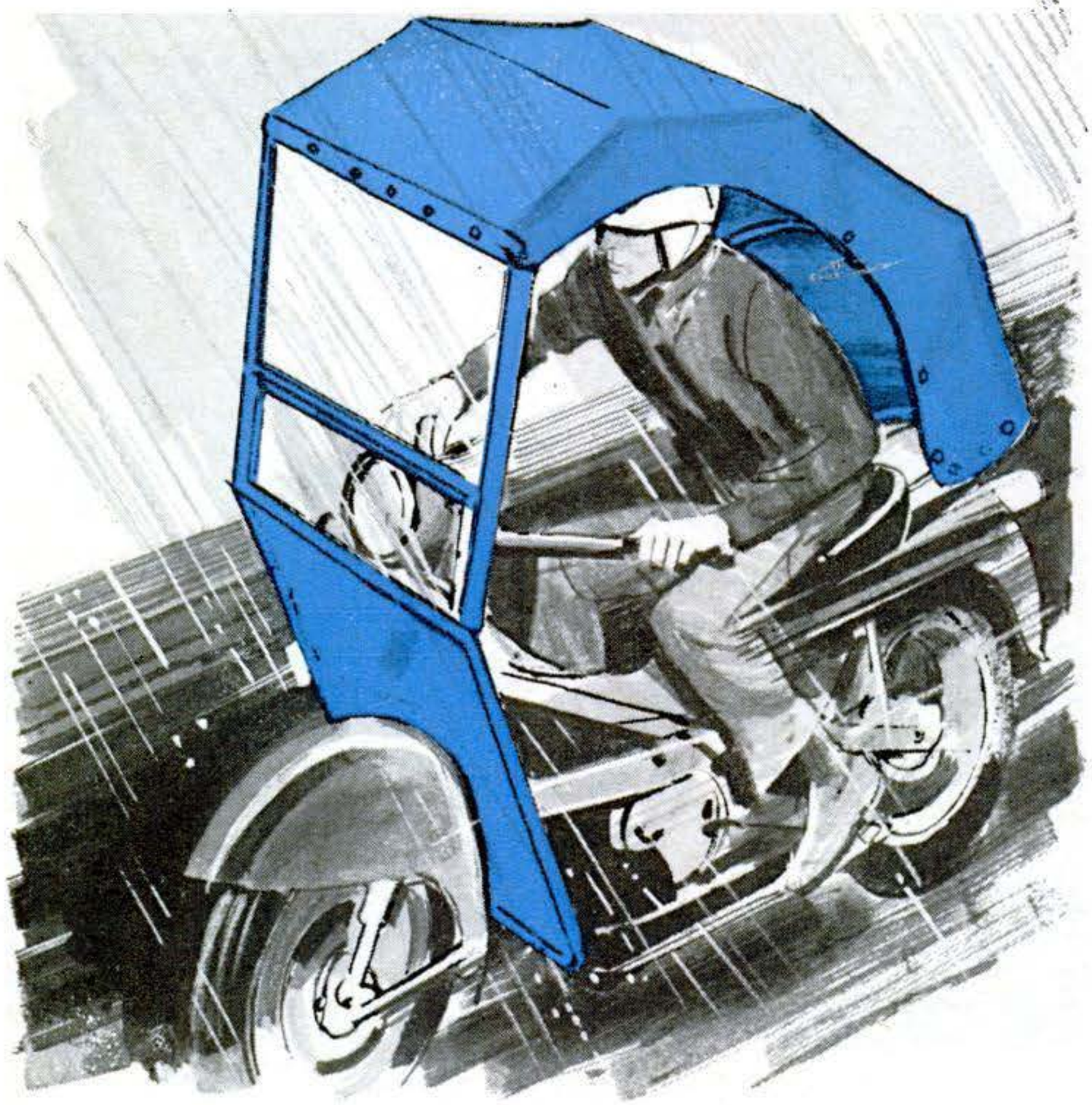
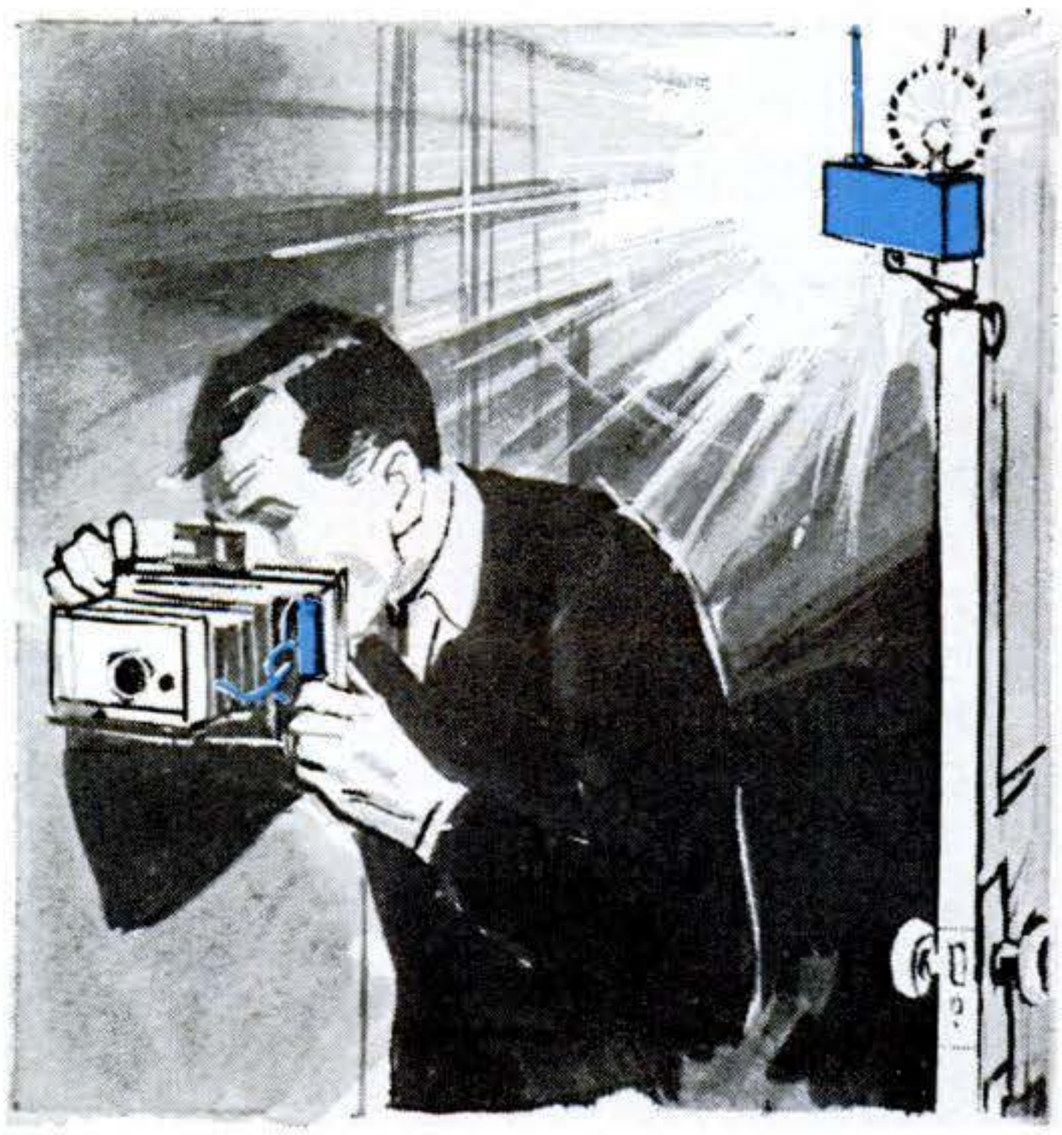
New Ideas from the Inventors

DRAWINGS BY WILLIAM CASTIMOR



Cycle top shields rider. A motorcycle rider could protect himself from rain and road splashes with this recently patented attachment. Fitted to the front of a cycle or motor bike, a spray and wind shield would support a snap-fastened fold-up canopy, streamlined to reduce wind resistance. Side panels could be attached, if needed, for extra protection. The top could be removed when not in use, or carried folded on the seat.

Water turns powder to paint. Water-based paints might be carried and stored more easily if they were supplied without the water. This powdered form would come in measured, moisture-tight packets to be mixed with water when needed. Full or part packets could be combined to adjust colors or quantities. A water-soluble inner pack could be used to eliminate spillage.



Radio triggers remote flash. A compact radio transmitter, according to this Polaroid patent, could be used to synchronize and fire a remote flashbulb. It would be plugged into the camera's flashbulb socket and would be operated by the impulse that normally fires the bulb. The remote flash unit, containing a tuned radio receiver, would need no wired connection to the camera.

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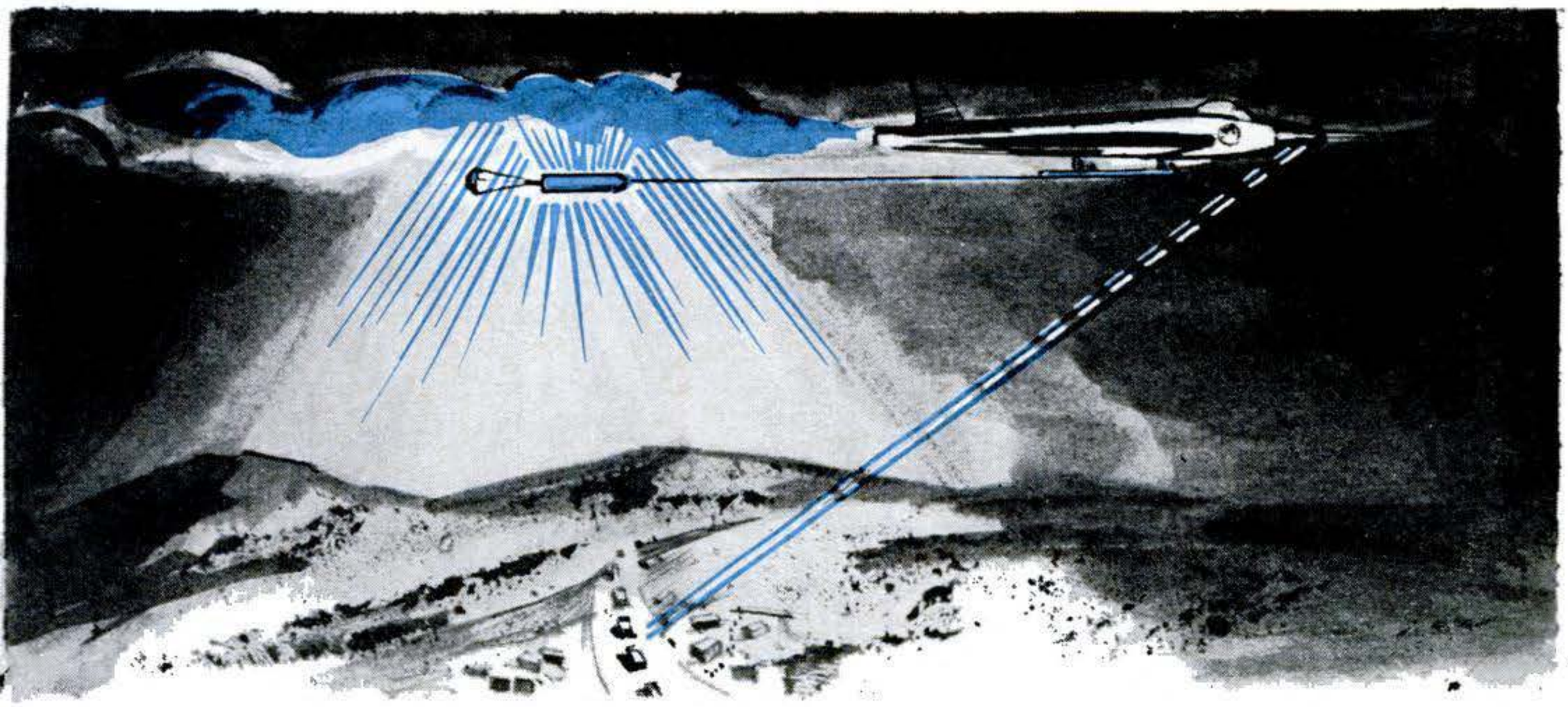
Door latch lights lock. You'd never have to fumble in the dark to unlock your car if it had a light like this built into the base of each front-door handle. Pressing the latch button would turn on the light. The slide contacts in the handle would not interfere with normal working of the button and latch when the door was unlocked.

Ladder perch improves footing. A hook-on ladder platform like this could make it easier, more comfortable—and possibly safer—to do jobs that keep you standing for a time in one place. Hooks on the metal perch would slip over a rung; a crossbar, resting against the ladder's side rails, would hold the platform steady and level.



Chemical cloud reflects photo light. A photo-reconnaissance plane, says this inventor, could get better night shots if it generated a trailing cloud of dense white chemical smoke. The cloud would reflect to earth the light of a towed, chute-supported flare. The light of a single flare could be used for many high-speed photographs.

The following patents have been issued on these inventions: **Cycle top**—*No. 3,284,130 to V. Michael, John Day, Ore.;* **Paint powder**—*No. 3,294,224 to H. Horwitz, Monsey, N.Y.;* **Remote flash**—*No. 3,295,426 to E. Land, Cambridge; R. Chen, Brockton; J. Lothrop, Westwood, and R. Wareham, Marblehead, Mass.;* **Door light**—*No. 3,280,321 to J. Overesch, Menasha, Wis.;* **Perch**—*No. 3,294,197 to R. Kwiatkowski, Erie, Pa.:* **Photo cloud,** *No. 3,338,147 to G. Goddard, Chevy Chase, Md.*

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington, D.C. 20231, at 50 cents each. To write to an inventor, if the address above is insufficient, address him (by name and patent number) in care of the Commissioner of Patents.

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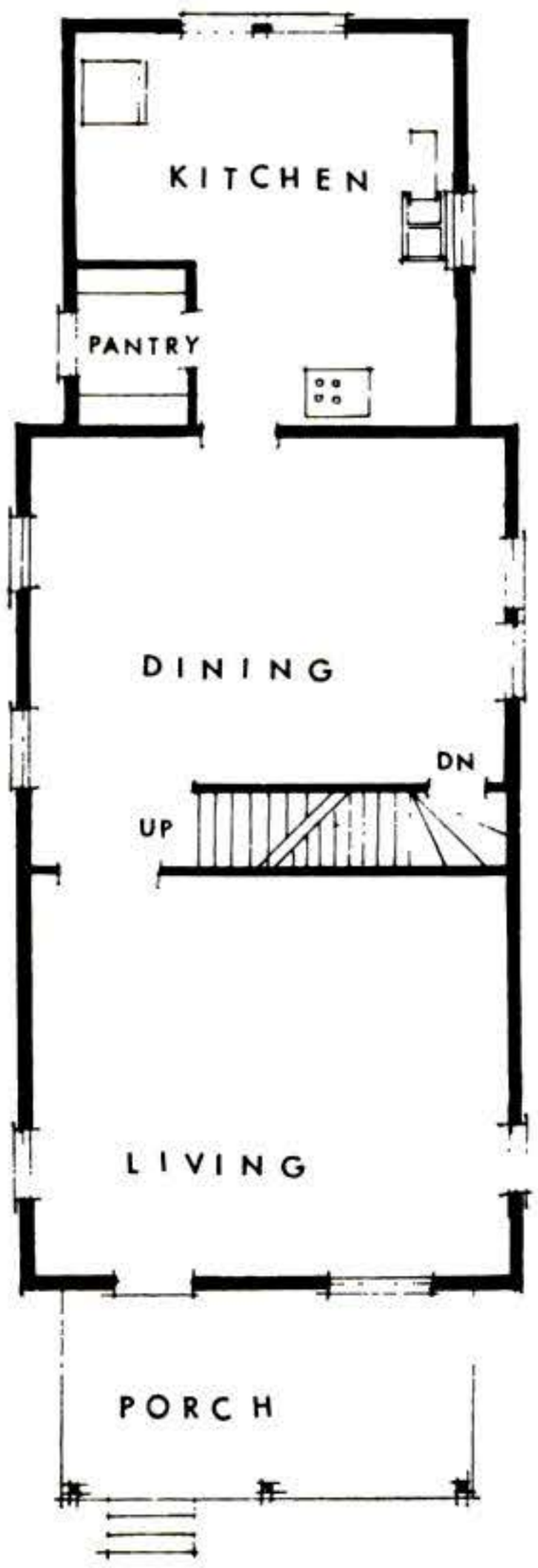
7 Common Pitfalls



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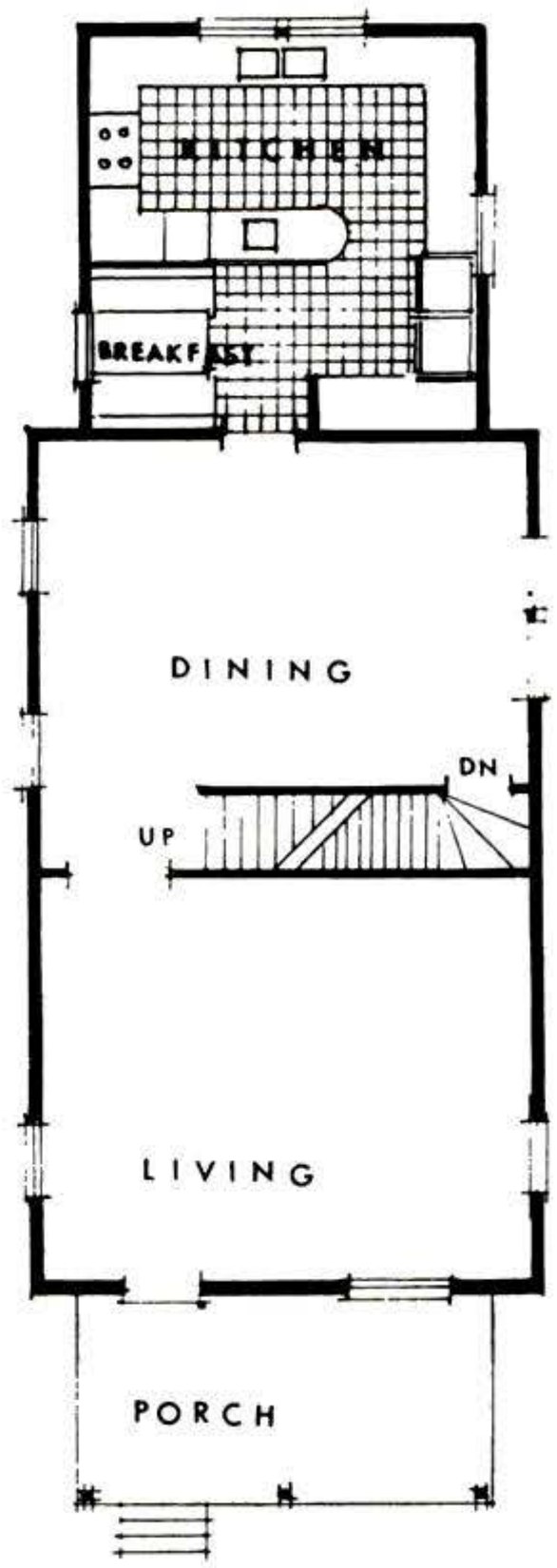

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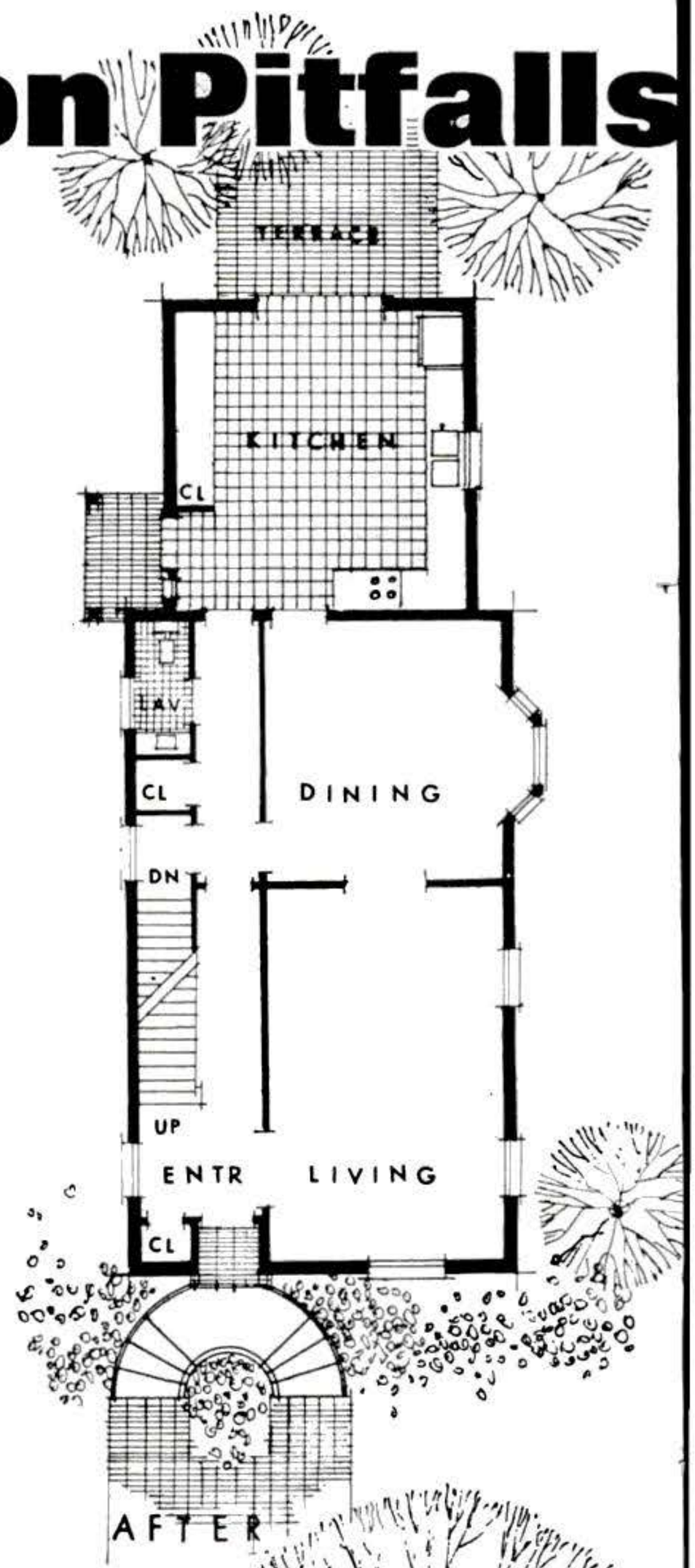

AFTER

BEFORE

AFTER

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# of House Remodeling

...and how to avoid them

A. J. Harmon is "an opinionated man." The jacket blurb of his recently published book, "The Guide to Home Remodeling," says so. So we figured that here was a man who should have many good ideas for PS readers. He does—and he presents some of them in this article. If you'd like to read more of his good ideas, here's a tip: His book was a recent selection of the Popular Science Book Club.—The Editors.

By A. J. HARMON, A.I.A.

ONE

The greatest pitfall in remodeling is in not seeking the professional help of a local registered architect—akin to having an illness diagnosed by the man at the corner drugstore instead of seeking a doctor. No qualified architect who takes you on as a client is going to insist on unwarranted or expensive changes in your house any more than a competent physician is going to put you in the hospital for a head cold. There may be times when you do not need an architect. If you do not, he will tell you so.

TWO

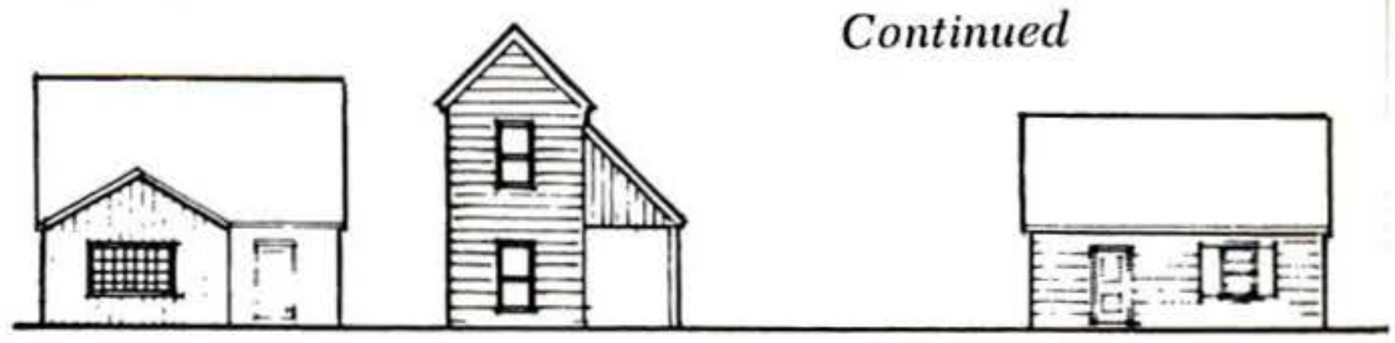
"Overbuilding" the house is probably the most common mistake a home owner may make. Possible results are shown in the drawings on the facing page. Modernizing the kitchen of a $15,000 house for four or five thousand dollars (center) without making needed improvements in other areas of the house is not a good idea. It is better to spend two or three thousand dollars on the kitchen (right) and use the remainder of the money to correct design flaws, add a laundry and another bathroom, improve the landscaping, or even buy new furniture.

A modern kitchen is valuable in every home, but it is the design of the kitchen that makes it an easy place in which to work; it is the quality of the fixtures and appliances that makes them a good investment; it is the choice of colors and the placement of windows that make it a cheerful room. The so-called "kitchen experts" and kitchen contractors may possibly get you a respectable kitchen, but they are interested in only that and not in the house as an entity or as a place in which to live. Your home should be a "total thing," not just a collection of miscellaneous architectural fragments.

THREE

A third pitfall in remodeling is related to the second in that it is amplified over the entire house until the house is overbuilt for the neighborhood. (See the sketches below.) It is spending $30,000 to remodel your home in a neighborhood of $15,000 houses. This is not necessarily

Continued



BEFORE

AFTER - OVERBUILDING

AFTER - SCALED REMODELING

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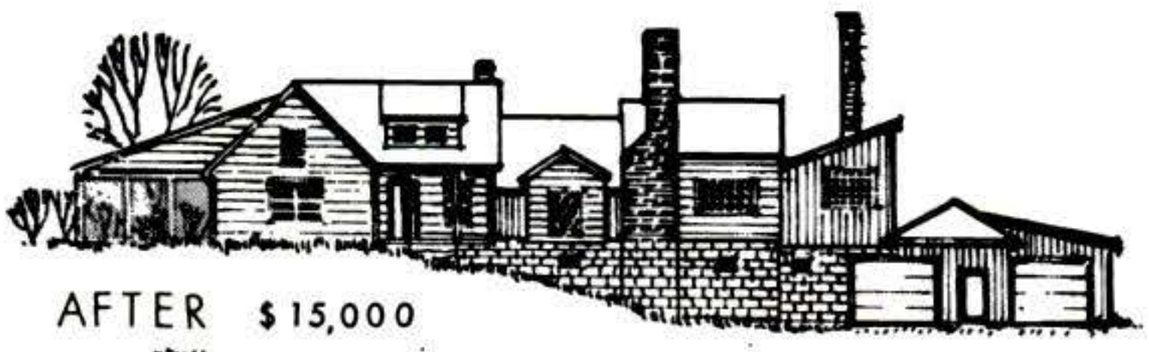
wrong, because the pleasure and security we obtain from a home cannot be measured in dollars. But if you ever try to sell your house or borrow money on it, you will find that it has been a poor financial investment.

It is easy to become too enthusiastic once you start to remodel and then find that you have invested more than you planned and perhaps more than you can afford. Regardless of how much you like and admire the completed house, you may be unhappy in it if you must use every minute of your time to pay for the remodeling. Living in a house you cannot afford can make it uncomfortable, and if you are forced to sell and must accept little more than the prevailing neighborhood prices, you will have lost money.

If you do not know the value of your neighbors' properties, call in a real-estate broker or appraiser and ask him about prices in the area. Then formulate a plan and a budget, and stick to it.

BEFORE



AFTER $15,000

AFTER $10,000

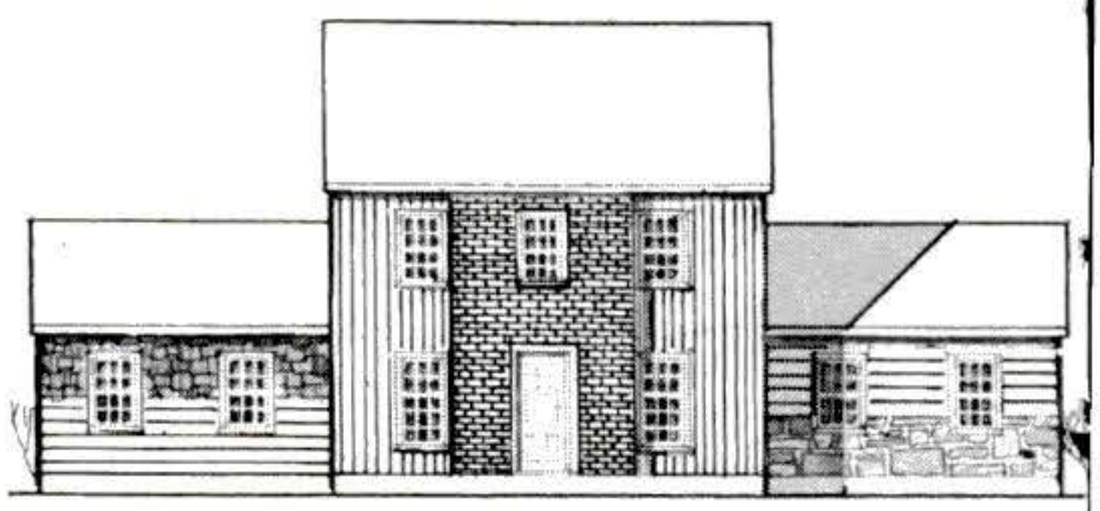
FOUR

A serious pitfall is not having an overall plan for your remodeling, as indicated above. One tends to do a bit here and a bit there over the years—like adding a porch or a fireplace, putting in a dormer or adding a garage, without giving any serious thought to the design aspect of the completed house. Many families cannot afford or do not wish to remodel the entire house all at once, but prefer to add rooms as their families grow and as their incomes increase.

In such cases, it is crucial to have a long-range plan. Everything done to the house must be a contribution to the final design, yet be complete enough in itself to give the house a finished appearance. It can be upsetting to live in a house that is in a constant state of reconstruction. The additions and changes you want to make in the future must be anticipated so that mechanical connections and structural elements can be completed in the shortest time possible with no disruptions of the previous changes. Planning, design, and imagination are far more important in your remodeling than money.

FIVE

Another remodeling pitfall to avoid is shown below—the use of too many different materials on the exterior. The smaller and more modest the house, the more important it is to simplify the facade. The indiscriminate combinations of brick, stucco, stone, vertical siding, horizontal siding, and shingles make a house look smaller and—in effect—cheapen all the materials. The many different elements make it look as if the house had been assembled from a junkyard, and the result is still worse if everything is a different color. You should not attempt to change the siding part way up the wall; it is expensive, apt to leak, and can be esthetically unpleasant.



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If your house is already a hodgepodge of materials and you cannot afford to change them, paint them all the same color to unify the facade. Usually a dark color is better because the shadow lines and textures are absorbed. Additions may sometimes be of another material if it does not add another texture to the exterior.

SIX

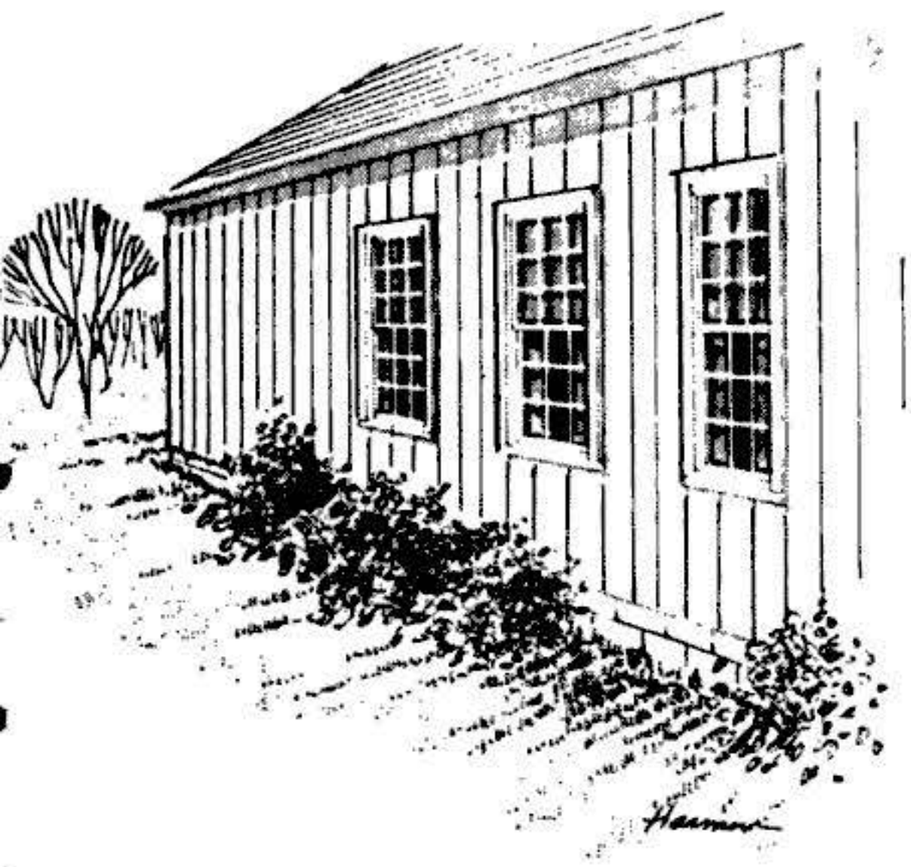
A not unusual mistake in remodeling is getting oversold on a finished basement. There may be some space there that could be put to better use, but most basements are a poor place to invest money—whether for a playroom, game room, bedroom, laundry, study, workshop, or the frightening fad of five years ago—the fallout shelter.

Basement ceilings are usually low to begin with and even lower when finished around pipes and ducts. And the basement can be damp and clammy even though there are many ways of getting sunlight and fresh air into it. Most important, what are you going to use the basement for? An expensive playroom for the children? It is all right if they are going to use it, but too often this lasts only a year or two on rainy days, and it is difficult to supervise very young children or teen-agers a full flight of steep stairs away. If it is to be an adult game room your guests are going to think you're afraid they will ruin the living-room carpet and, unless the access is through the entrance hall, everyone will have to wind through the house and the kitchen to get to the back stairs.

The basement is not a good place for bedrooms. Older people, for psychological reasons, will complain of the dampness and cold walls and floors, even if they're bone-dry; children feel demoted and like second-class members of the family if they're made to sleep there; guests may resent being stuck down in the cellar for the night. A washing machine and dryer will add to the dampness and double the work of doing the laundry because the clean clothing and linen must be hauled back upstairs even if you have a laundry chute to get it down there. The basement does not usually work out well for a library or study because books and papers get musty and moldy. Don't build a shop in the basement, either; noise from the machinery will get carried throughout the house; wood, paint, and other materials will have to be carried down and then out again and create a fire hazard when stored there.

This is not the place to go into the social, psychological, and international ramifications of fallout shelters, but my advice to anyone considering a fallout shelter in the basement is—don't. If you want a playroom or game room, add it where the children can be close to the kitchen and the outdoors; or convert the

Continued



BEFORE

AFTER

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garage into another room, and either build another garage or carport or leave the cars out in the rain—water won't hurt them.

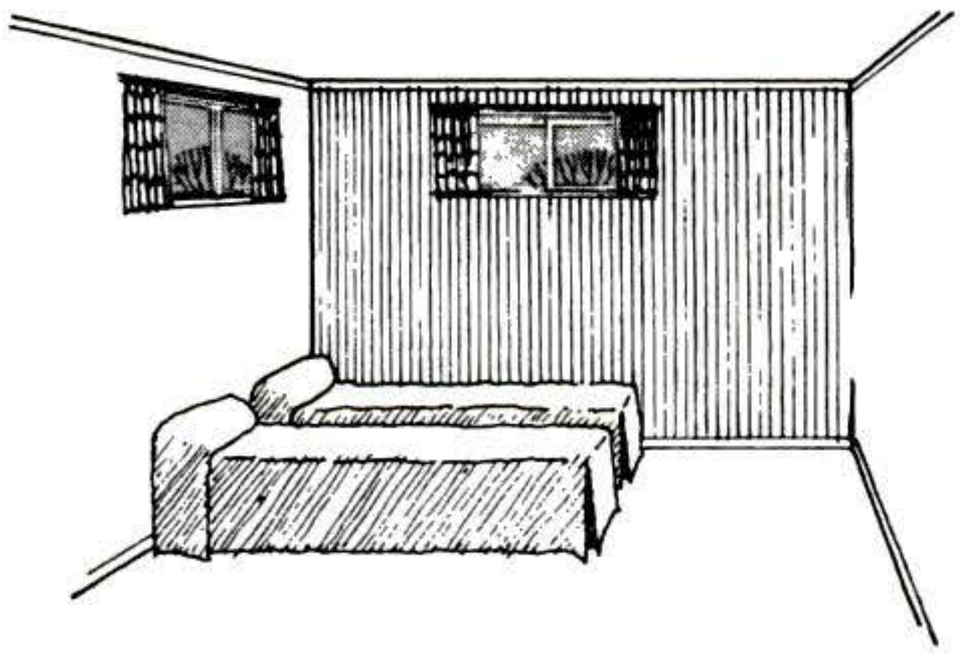
If you need additional bedrooms, build them where you can use them comfortably—in a wing, or by adding a second floor. If you want a laundry, add it near the bedrooms where the soiled clothing is discarded and the linen is stored, instead of putting the laundry in the basement.

However, if you still are inclined to "do something with the cellar," be sure that there are, or that you build, two separate exits and that one of them leads directly to the outdoors in case of fire. My sketch (preceding page) shows an exit that also provides air and light.

SEVEN

This brings us to the most dangerous pitfall in all remodeling—the fire hazard. Some older homes, particularly those built in developments just after World War II, have inferior material and equipment and are firetraps. In every remodeling, have the heating and wiring checked and get it in perfect shape before or as you remodel. Then eliminate the dangerous elements of the design. Do not have a curtained window within three feet of the stove or any window over it; have more than enough electrical outlets and do not use extension cords. Put in circuit breakers instead of an old-fashioned fuse box.

Create a front and a back entrance. Have two exits from the basement, and a fire exit from the second floor and the attic if there is one. Do not put up with, or add, bedrooms with high, narrow, horizontal windows. In houses with bedrooms so small that beds can be placed in them only if they have such windows, enlarge the rooms and replace at least one of the windows with one that has a low sill. In remodeling bedrooms or adding new ones, have at least one window low enough to the floor so that a child or an elderly person can get to it and escape in case of a fire (below, right). If the windows are on a second floor or three or four feet from ground level, add a small balcony on the exterior. This will eliminate worry about tots falling out the window and, incidentally, make window washing much easier. PS



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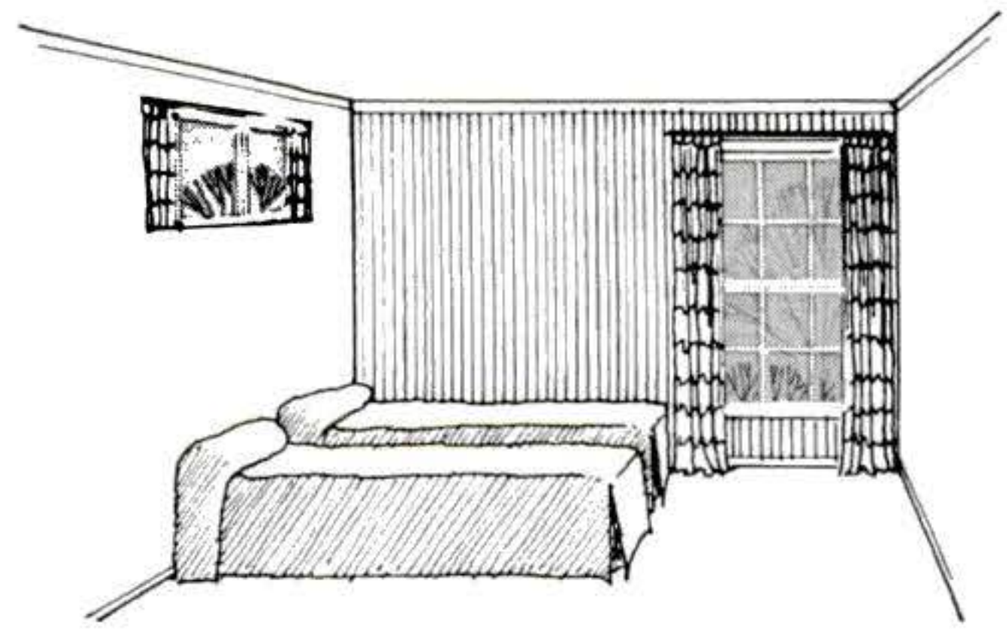

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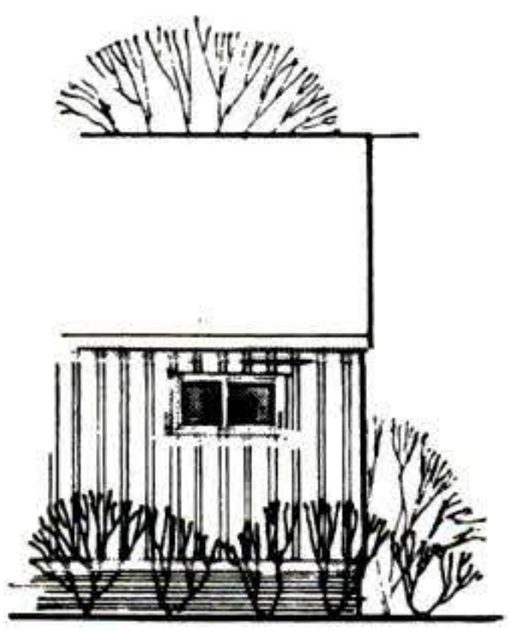

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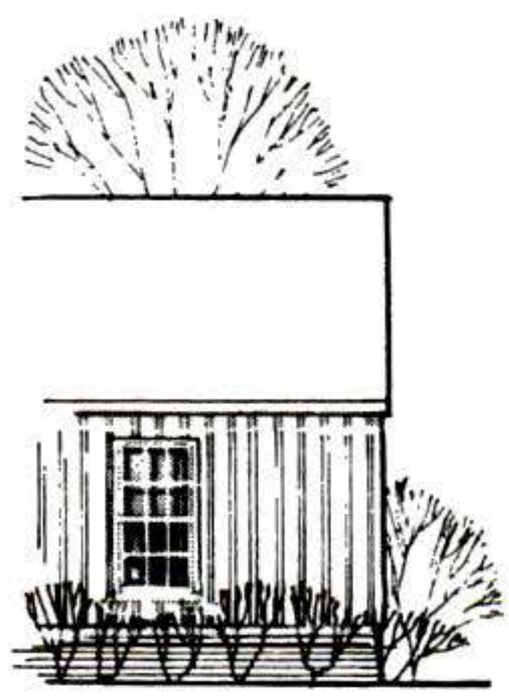

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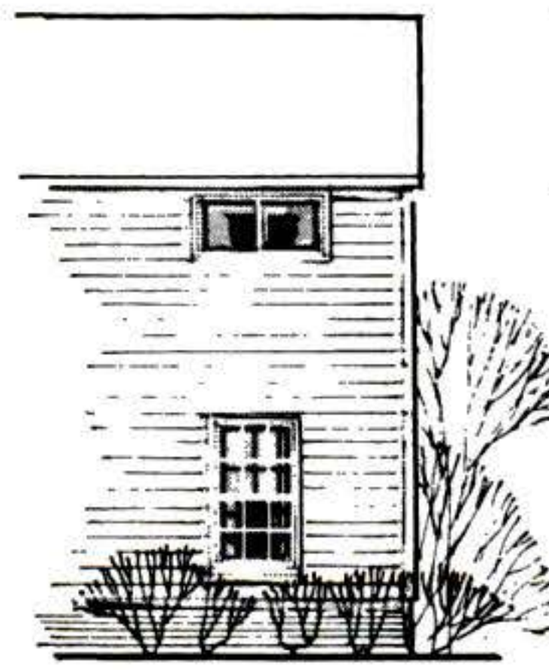

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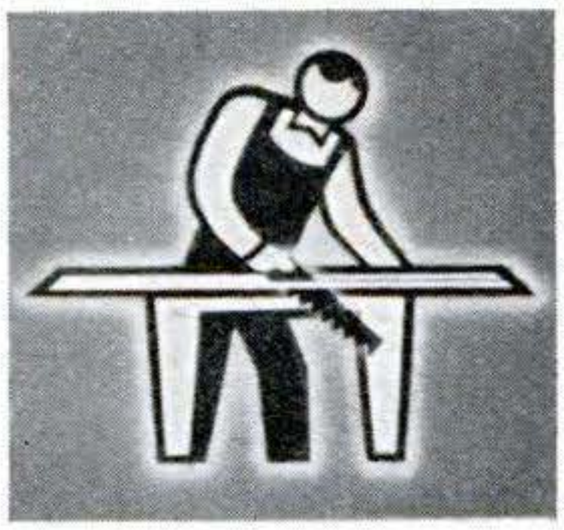
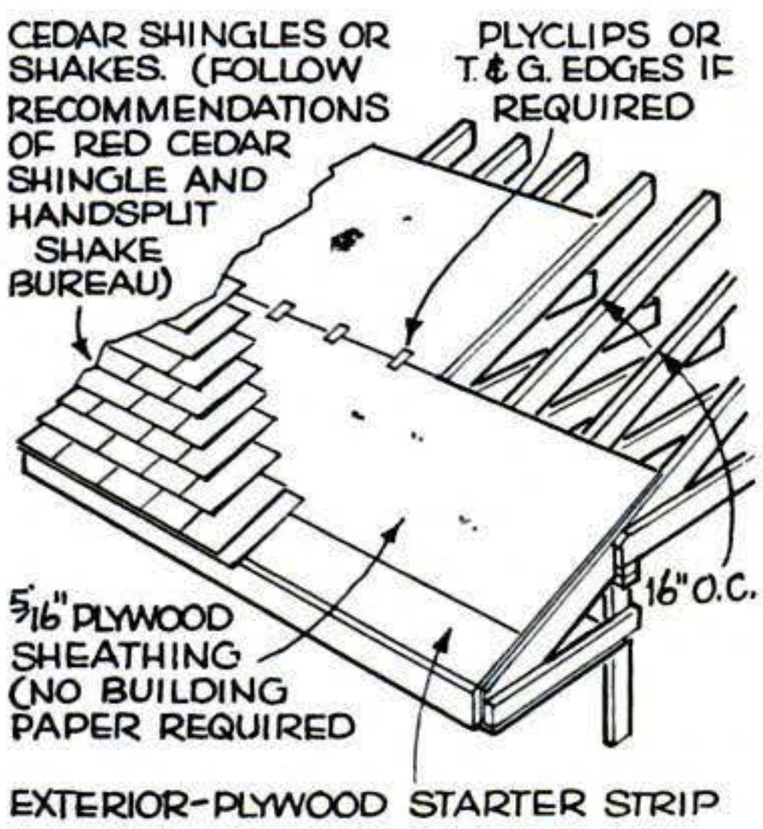


Shop Talk

By ROBERT P. STEVENSON

It's okay to put wood roofing shingles over solid sheathing

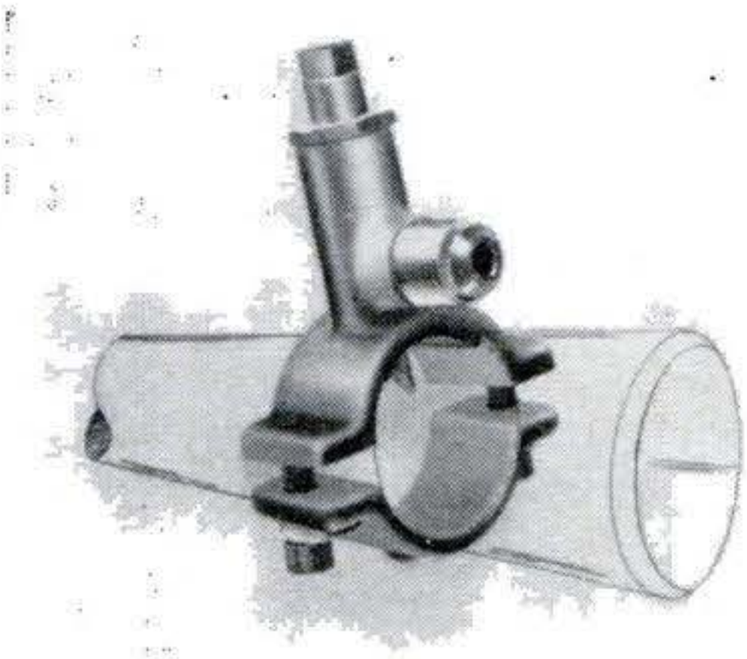
Some years ago, when I needed a new roof for my detached garage, the builder offered me a choice of composition shingles over plywood sheathing, or red-cedar shingles on the existing one-by-two furring strips that ran horizontally about 6″ apart under the old wood-shingle roof. Wood shingles were always nailed to such spaced strips, I was told, so the undersides of the shingles could "breathe," dissipating moisture that contributed to decay. But I now learn that this age-old belief has been disproved. In a recent report, the American Plywood Association says: "Although the traditionalist sometimes insists that a solid deck under cedar shingles contributes to decay, the facts do not support such contentions. This matter has been thoroughly investigated, and has long since been laid to rest as an old wives' tale."



A Purdue University survey of 695 wood-shingle roofs ranging from one to 60 years old (23 average) found no significant difference in shingles applied over either a solid or spaced base.

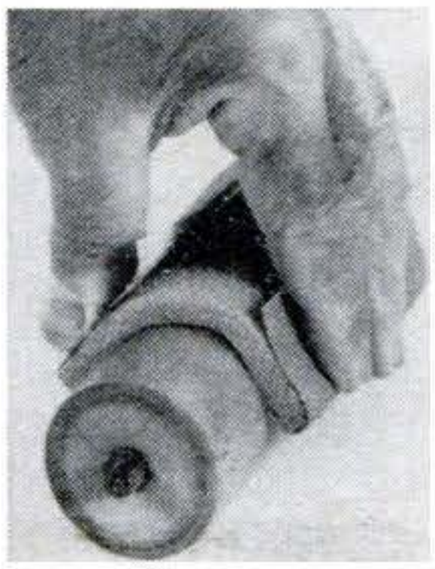
The plywood association points to a number of case histories. The first goes back to 1938. In that year, cedar shingles were applied over a $\frac{5}{16}$″ plywood deck on rafters spaced 16″ o.c. After 21 years, the owner remodeled. When some of the shingles were taken up to change the roof configuration, the entire roof system was found to be in fine shape and it still is—after more than a quarter of a century.

The sketch shows the recommended application for homes.



Valve lets you tap water, gas lines without cutting

The accompanying photo shows a remarkable new piece of industrial hardware that may eventually have home applications. Introduced by the Sealed Unit Parts Co., 1178 E. 180 St., NYC, it's called the Insta-Flow Tap Valve. You clamp it on a water or gas line where a new tap line is desired. Then you turn the spindle with a wrench, forcing a stainless-steel piercing needle through the pipe. It's said to be capable of piercing galvanized pipe of up to 1″ diameter and copper tubing of up to 1⅜″ outer diameter without interrupting the flow.



Two useful shop techniques you may want to remember

There's a good trick you should know about Plyfoam, an expanded polyvinyl chloride foam material. Dip a piece into boiling water and you can bend it to the shape desired—for instance, to a form-fitting sander block for curved surfaces (see photo). When cool, the foam becomes rigid again. To try it, send $1 to Plyfoam, Inc., Vanderbilt Industrial Park, Hauppauge, N.Y. 11787, for two 7″-by-10″ pieces of the material. . . . Those all-thread rods several feet long you see in hardware stores are easy to cut to exact length. Turn up a nut to each side of the point where you want to cut. Saw between the nuts.

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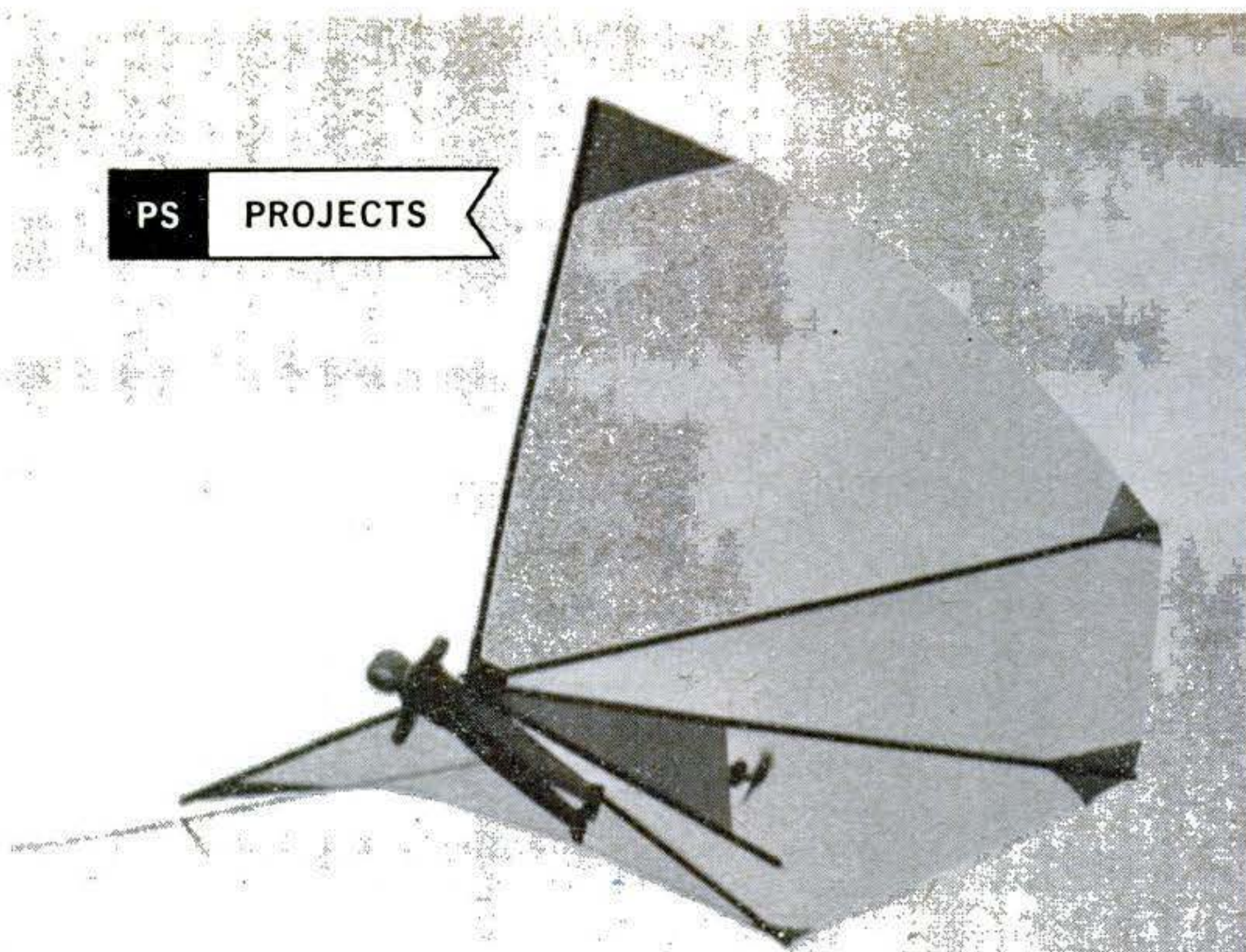

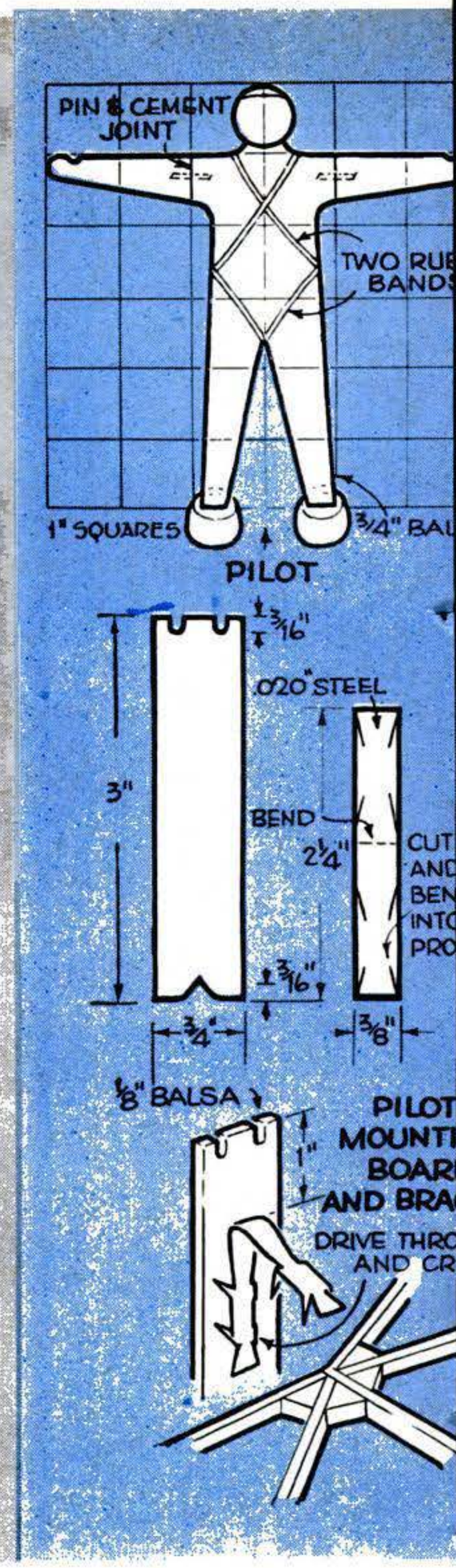

Birdman Kite

Yearn to soar like a bird? Try the next-best thing: Send up this easy-to-build proxy flying model

By ROY L. CLOUGH JR.

Your imagination will take wing, too, as you watch this model climb the sky. It's more than a kite, though you can keep it tethered like one in a light breeze. You can also tow it up and cast loose to let it glide down on its own. Either way, the propeller windmills to suggest powered flight.

Man has cherished the dream of flying like a bird for centuries; history is full of accounts of people who strapped homemade wings to their backs and jumped off barns and bell towers to the greater profit of bonesetters and morticians. But these would-be birdmen didn't know how to shape their wings, they had no power but their muscles, and their materials were woefully inadequate.

Today, things are different. We know a lot more about flight. We have both the power and the materials at hand. Consider what might be done with tubular fiberglass spars, gossamer-thin Mylar wings with the strength of sheet steel, and a hopped-up kart engine:

You shrug into a harness and yank a starting handle. The tiny motor behind you snarls to life. Run a few steps into the wind—and you're airborne! Climb like an eagle. Wheel gracefully like a gull, banking and turning with

[Continued on page 199]

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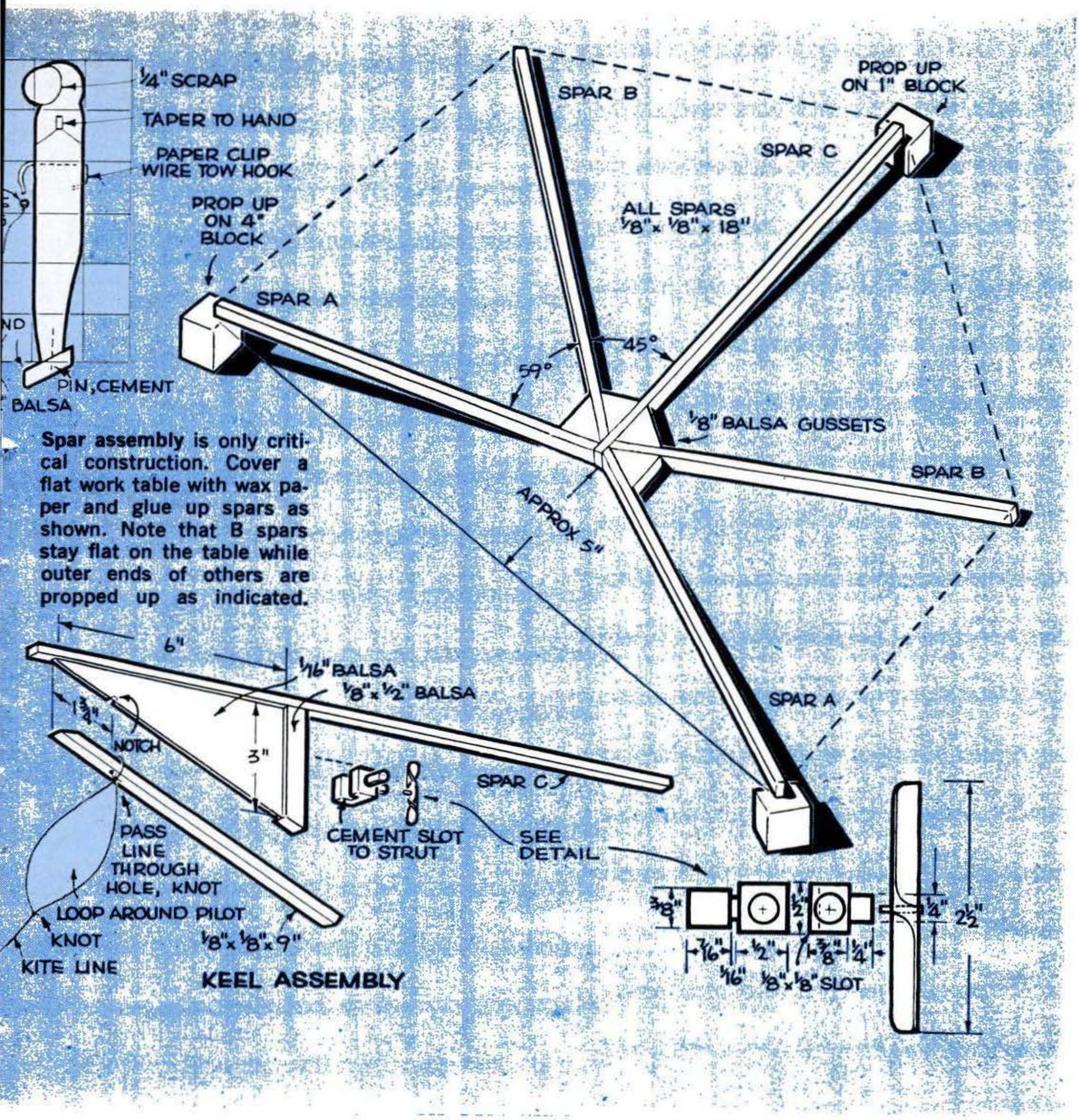
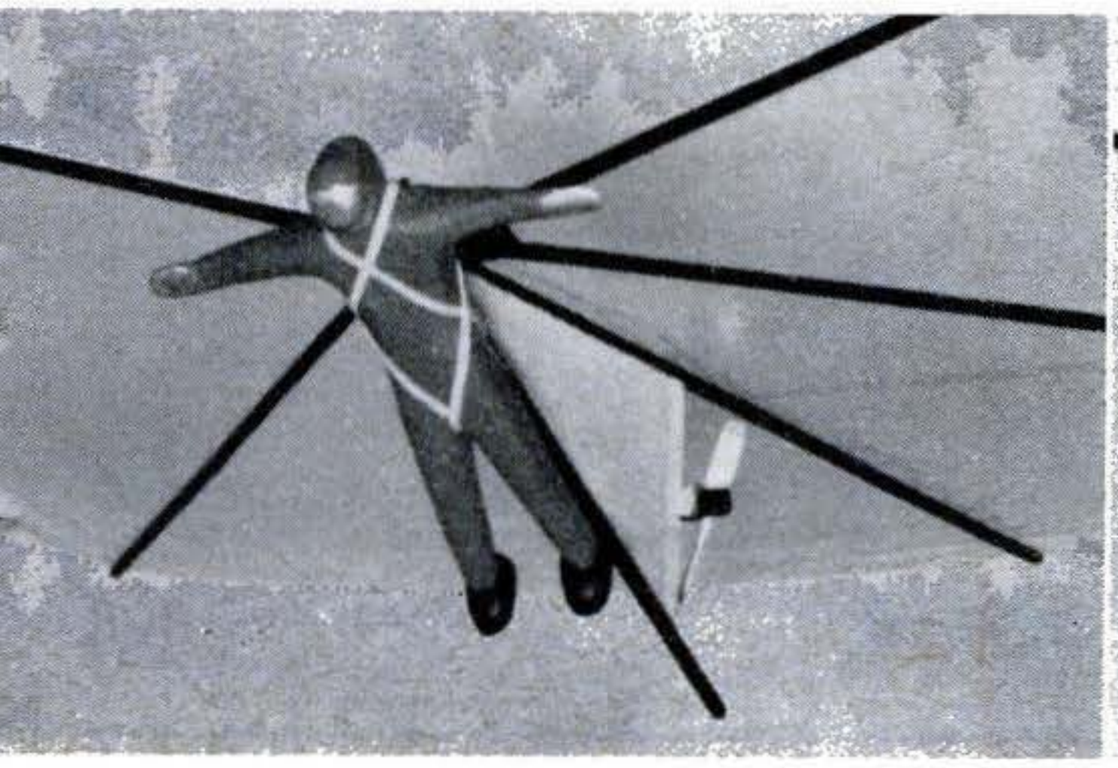
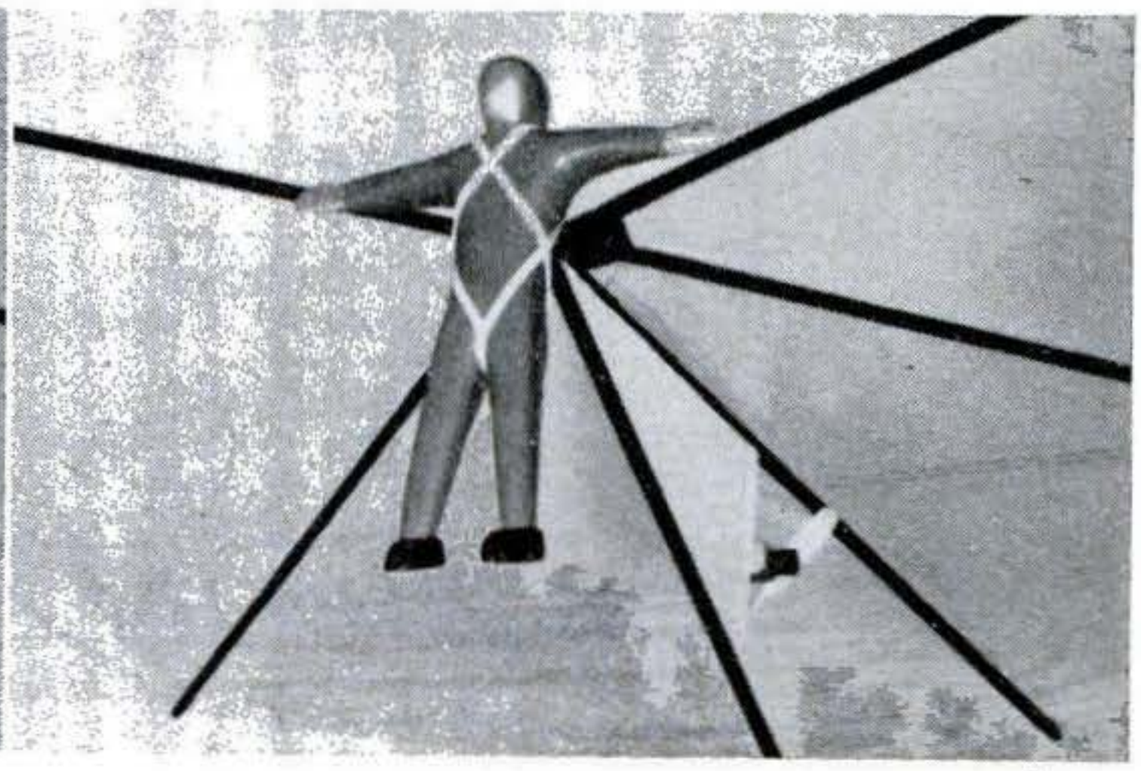


Spar assembly is only critical construction. Cover a flat work table with wax paper and glue up spars as shown. Note that B spars stay flat on the table while outer ends of others are propped up as indicated.

Adjustable model pilot demonstrates logical flight positions for man in full-scale rig of the future. After standing takeoff, pilot would swing his legs back (left) to hook heels over a crossbar—not only less tiring for long distances, but an effective way to cut wind resistance. Gliding in for landing (right), he swings back into vertical position, manipulating wings to cut speed and touch down at an easy run.





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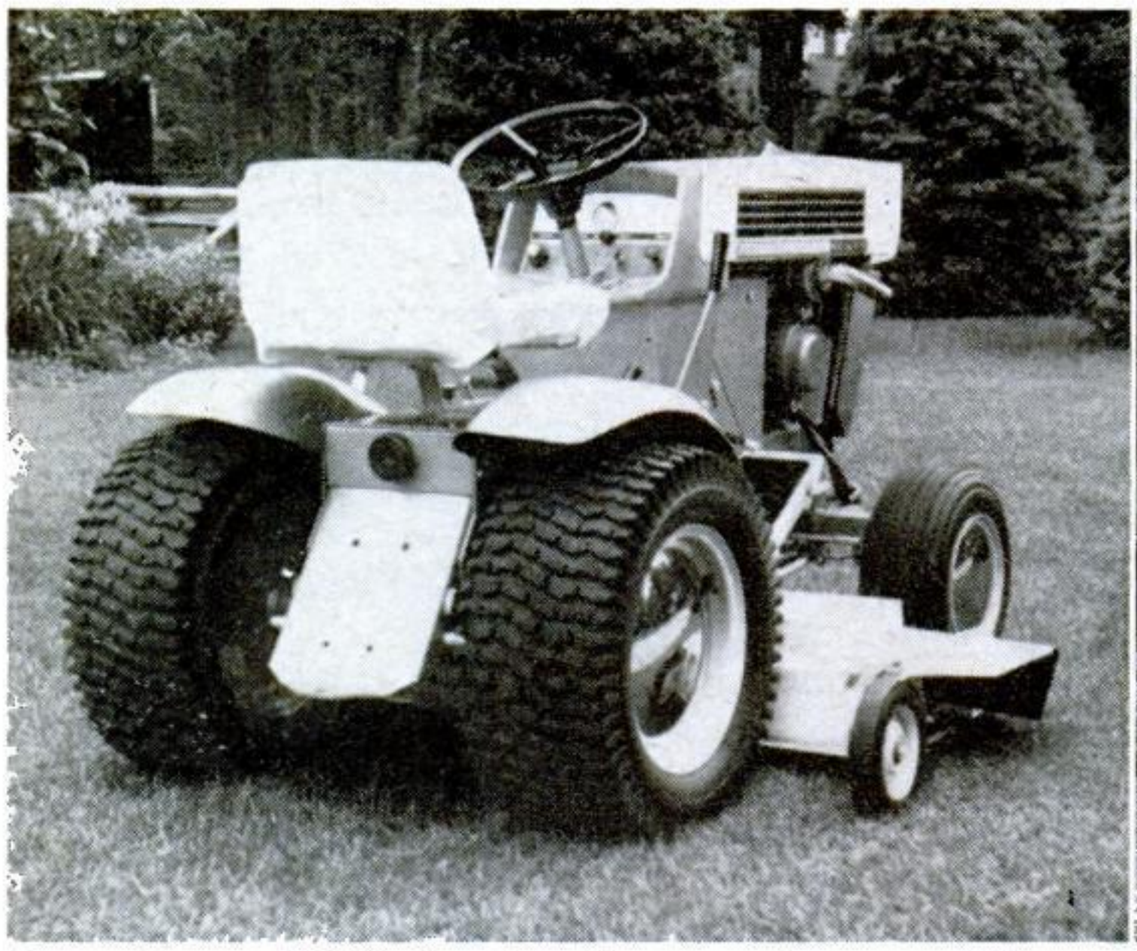
Bolens 1250 is a 12½-hp. machine with hydrostatic drive, hydraulic lift, and three-point rear hitch. Bolens features solid drive shafts and U joints.

Ward's Squire 12 has red panel light to warn that PTO is engaged. Special sump on synchro-balanced Briggs engine forms part of frame, lowers gravity.

Toro 10-hp. and 12-hp. models offer unusually wide front tires. Padded armrests add comfort, gear-shift detents aid control.

Simplicity Sovereign 3012 demonstrates the antiscalp design of its axle and cutter deck. Simplicity has range of 34 attachments.

International Cub Cadet comes in hydrostatic or gear-drive model, mounts a 48″ rotary mower, boasts good comfort.



Sears Super 12 Hydro-Trac has great grass-cutting ability and smooth hydro drive. It's also available with gear drive. Both have solid-state ignition.

Gilson S-12 offers gears plus variable-speed drive for flexible control. Hydraulic implement lift and contoured frame are new features for this season.

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J. I. Case 10-hp. and 12-hp. tractors offer hydraulic lift. In picture, rig is applying downward pressure on grader blade, one of many accessories.

Massey-Ferguson MF-12 is one of fastest at nine m.p.h. Worm-gear steering and heavy axles help in rough going; 12-hp. engine has solid-state ignition.

Buyer's Guide to '68 Garden Tractors

New crop of Big G riders turn the chores in any man's private domain into fun

By E. F. LINDSLEY
PS Outdoor Power Equipment Editor

Engineers who design lawn and garden tractors know them as LGTs. If you live in a house with a fair-size lawn, a garden, and a drive or a walk, it's a good bet you're considering one right now—if you don't already have one. Some important things have become obvious this year in LGT design, power, and product-use intent:

- You'll find good basic designs for lawn care in the seven-hp. range.
- You'll find sophisticated designs for broad lawn, garden, and utility use in the 10-hp. and 12-hp. range.
- Between these ranges, you'll find fewer models trying to be both lawn and garden tractors.

There's no question about that third point. A weeding and sifting of powers and capabilities has leaned down the LGT market to full-fledged garden tractors at the top and some very practical lawn tractors at the other end.

Deluxe versions of all models, large or small, offer enough good things to steal the heart of the most discriminating. But the manufacturers have shrewdly trimmed these same models for the economy-minded who are seeking work muscle without garnish.

Before you buy, ask to see the full catalogue of options and features in your chosen product line. It may be worth several hundred dollars to pick and order rather than take a model off the floor.

The Big G tractors. When you go LGT shopping you'll find most of the major builders offering 12-hp. models. The list —with L signifying hydromatic lift and T hydromatic transmission—reads like a Who's Who in the LGT game:

Allis-Chalmers, Model B-122; Bolens, Husky 1250, T and L; Deere, 140, T and

Continued

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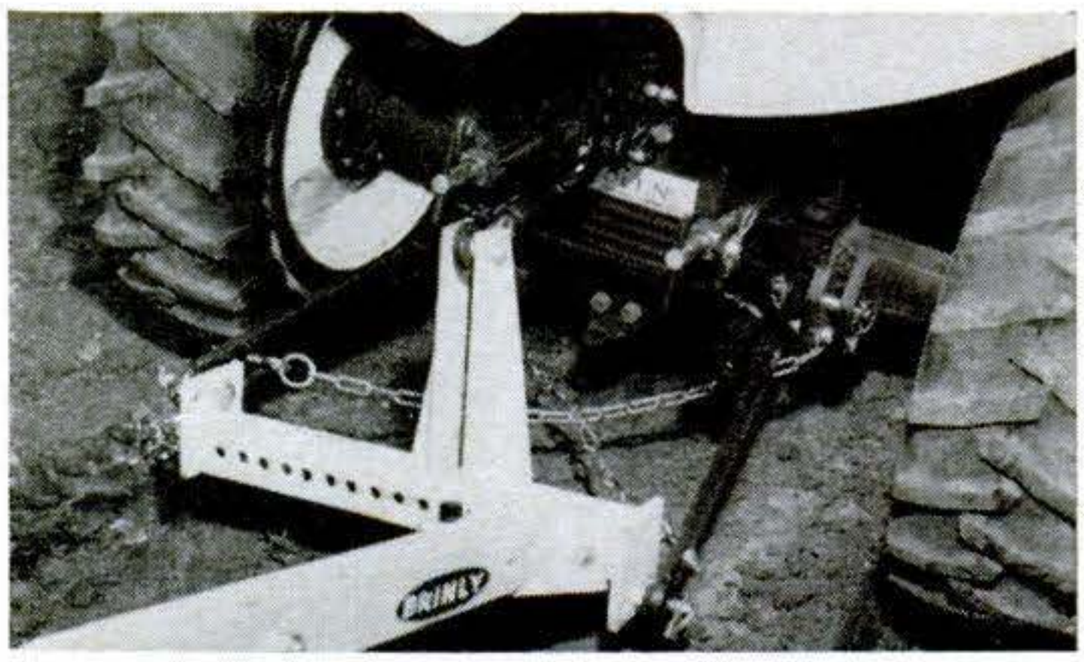
Will a lawn tractor serve your needs? Here are two examples

Ford Model 70, one of the newest on market, has manual start and seven-hp. engine. A companion model offers electric starter for those who want it.

Wheel Horse Ranger, at six hp., is a high-level lawn tractor. Note big rear wheels and husky front suspension. The company offers a two-year warranty.

Two good mechanical features

Electromagnetic clutch (the disk above front cross member) is engaged by a dash switch to drive implements on the highly sophisticated John Deere 140.



Three-point hitch and hydraulic lift on Bolens 1250 raise and lower implements effectively, help make this machine equal to a big-acreage machine.

L; Engineering Products Co., Power King, L; Ford, 120, T; Gilson, S series, L; International Cub Cadet 125, T and L; Jacobsen, Super Chief 12, T; J. I. Case, 195, T and L; Massey-Ferguson, MF-12, T; Montgomery Ward, Squire 12, L; Sears, Super 12 Hydro-Trac, T; Simplicity, Sovereign 3012, L; Toro, Suburban 12; and Wheel Horse, Charger 12, T.

Options. Not all the hydraulic implement lifts are standard. Engineering Products, International, Case, Ward, and Simplicity, for example, offer them as options. And it's not necessary to go all out on hydrostatic drive and deluxe options to get 12 hp. Gilson, International, Sears, Wheel-Horse, Ford, and possibly others offer both a hydro and a gear-drive version of their 12-hp. machines. Conversely, hydrostatic drive is available with 10 hp. on Ford, International, Jacobsen, and J. I. Case. Wheel Horse offers it at nine hp. on their Charger 9. These examples bear out opinions often expressed by LGT industry engineers:

- Hydrostatic drive is convenient, especially for unskilled operators.
- Hydrostatic drive probably has its greatest value in earth-working, where sudden pull-downs call for quick shifts without clutching.
- Gear drives offer greatest power/use efficiency. Planetary drives such as the Gravely 424 also offer clutchless shifting.
- The 10-hp. tractor should not be sold

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Facts About Representative 1968 Lawn and Garden Tractors

ANUFAC-URER	NAME & MODEL	L or GT	APPROX. PRICE ($)	HP.	DISP. (cu. in.)	TRANS-MISSION: MECH. or HYDRO	RANGE-CHANGE METHOD	ATTACH. LIFT	START-ING	IGNI-TION	MAX. CUT ROTARY (in.)	FEATURES
lis-halmers	B-112	G	999	12	30.16	Mech. vari-sheave (dual) spur & bevel gears	Sheave, flanges	Man., mech. hyd. opt.	Elec. & man.	Mag.	48	3 PTOs; cont. diff.; sync.-bal. eng.
	B-110	G	820	10	23.94	Mech. belt, hi-lo opt., spur & bevel gears	Sheave, flanges	Man., mech. hyd. opt.	Elec. & man.	Mag.	42	3 PTOs; cont. trac.; sync.-bal. eng.
iens	To be announced in spring											
lens	Husky 1250	G	1,390	12.5	28.86	Hydro.	Hydro. & gearshift	Hyd.	Elec.	Bat.	48	Commercial qual.; Wis. eng.
	Husky 1050	G	870	10	22.03	Belt & gear	Gearshift, plt. clutch	Man., mech.	Elec.	Mag.	42	Wis. eng.; cont. diff.; shaft drive to attach
	Husky 850	G	775	8¼	20.13	Belt & gear	Gearshift, plt. clutch	Man., mech.	Elec.	Mag.	38	Wis. eng.; cont. diff.; shaft drive to attach
	Estate Keeper	G	825	10	22.03	Gear & diff.	Clutch gear-shift	Man., mech.	Elec.	Mag.	42	Ctr. pivot, rear eng.
las ol	R5124	L	350	5	12.5	Chain to trans. & diff.	Clutch gear-shift	Man., mech.	Man.	Mag.	24	Safety-blade brake
l. Case	195	G	1,185	12	29.07	Hydro.	Hyd.	Hyd. opt.	Elec.	Mag.	44	Hyd. pump and motor separate
	155	G	1,000	10	23.9	Hydro.	Hyd.	Hyd. opt.	Elec.	Mag.	44	Simplified service, positive neutral
ere	140	G	1,258	12	29.07	Hydro.	Hyd.	Hyd.	Elec.	Bkls.*	46	Elec. impl. clutch, disk brakes
	112	G	880	10	23.75	Mech., vari-sheave to transaxle	Stick-change on move; no clutch	Hyd. or man.	Elec.	Bkls.*	46	Adj. rear tread., dbl.-act. brakes
	110	G	816	8	18.6					Mag.	38	
	60	L	639	6	13.5	Mech., trans-axle, hi-lo	Stick	Man., mech.	Elec., man.	Mag.	34	17" turn. radius, worm steering
eVere	DeVere-Locke 10 Homesteader	G	740	10	23.9	Mech., hi-lo	Stick & clutch	Man., mech.	Elec.	Mag.	38	Rear PTO, int.-exp. brakes
ngineer-g Prod-cts Co.	Power King	G	929-1,049	12	29.07	Mech., auto-motive tandem opt.; final-drive spur at wheels	Stick & clutch	Hyd., mech. opt.	Elec.	Mag.	60	Powerful gear train for heavy work, attractive price & value
	Jim Dandy	G	844-938	12	Same as Power King except lighter; shorter, narrower frame							
rd	120	G	1,075	12	29.07	Hydro., mech. opt.	Stick & clutch	Man., mech.	Elec.	Mag.	48	Front-mounted reel mower opt.
	100	G	863	10	23.9				Elec.	Mag.	42	ACR
	80	G	816	8	18.6	Mech., 4-speed	Stick & clutch	Man., mech.	Elec.	Mag.	36	ACR
	75 Elec. 70 Man.	L L	Details to be announced in April									
eneral pliance	Bonanza 832T7PS	L	400	7	15	Transaxle	Stick & clutch	Man., mech.	Elec. opt.	Solid-state	32	Rear pickup box
lson	S series	G	1,150	12	30.10	4-speed, trans-axle, plus vari-sheave	Speed-shift lever, plus clutch & stick	Hyd.	Elec.	12V	48	Contoured frame S 12 has sync. bal. eng.
		G	1,000	10	23.94			Man., mech.				
	750	G	899	12	29.07	4-speed, transaxle	Stick & clutch	Man., mech.	Elec.	Mag.	38	Torque spring-drive shaft, many types of attach.
	723	G	799	10	23.9							
	772	G	749	8	18.6							
	779	L	625	7	16.7	3-speed, transaxle	Stick & clutch	Man., mech.	Elec.	Mag.	38	Wide utility for 7-hp. tractor
	778	L	525	7					Man.			
avely	424	G	976-990	10	23.9	4-speed, hi-lo axle, planetary	Stick, no clutch	Man., mech.	Elec.	Mag.	50	Unique trans., no belt drive; U joint & shaft to impl.
omelite	Yard-Trac	L	409	5	12.2	Friction drive	Stick & clutch	Man., mech.	Man. ACR	Mag.	26	Grouped controls, floating deck
terna-onal	Cub Cadet 125	G	1,115	12	29.07	Hydro.	Hyd.	Mech., hyd. opt.	Elec. ACR	Bat.	48	Cam & lever, variable-ratio steering, 3 Pt. hitch avble.
	105	G	1,035	10	23.9							
	Cub Cadet 124	G	960	12	29.07	Direct drive, 3-speed gears	Stick & disk clutch	Mech. or hyd.	Elec.	Bat.	48	Wide range of impl.
	104	G	885	10	23.9				Elec.	Bat.	48	
	72	G	680	7	16.22				Man. or elec.	Bat. or mag.		

Chart continued on next page

MANUFACTURER	NAME & MODEL	L or GT	APPROX. PRICE ($)	HP.	DISP. (cu. in.)	TRANSMISSION: MECH. or HYDRO	RANGE-CHANGE METHOD	ATTACH. LIFT	STARTING	IGNITION	MAX. CUT ROTARY (in.)	FEATURES
Jacobsen	LT700 Deluxe	L	498	7	15	Transaxle, 3-speed	Stick & belt clutch	Man., mech.	Man. or elec.	Mag.	34	Fuel gauge
	Super Chief 10	G	1,008	10	23.9	Hydro.	Hyd.	Man., mech.	Elec.	Mag.	42	
Magna American	Magna-Trac 9	G	798	9	22.97	Transaxle	Stick & cone clutch	Man., mech.	Elec.	Mag.	42	Expandable rear axle
	Magna-Trac 7¼	L	626	7¼	N.A.	Transaxle	Stick & cone clutch	Man., mech.	Man., elec. opt.	Mag.	42	Expandable rear axle
Massey-Ferguson	MF-12 Hydra-Speed	G	1,035	12	27.66	Hydro.	Hyd.	Man., mech.	Elec.	Mag.	42	Wide range of implements
	MF-10	G	849	10	23.75	Vari-speed & transaxle	Shift plus vari-sheave	Man., mech.	Elec.	Mag.	42	
	MF-7	L	445	7	15	Transaxle	Stick & belt clutch	Man., mech.	Man., elec. opt.	Mag.	34	Full-width deck-guide roller
Montgomery Ward	Squire 12 (M)	G	875	12	30.16	Cushioned shaft & belt to transaxle, vari-speed	Stick & clutch plus speed lever	Man., hyd. opt.	Elec.	Mag.	48	Contoured frame, low center gravity sync.-bal. eng.
	Squire 10	G	745	10	23.94			Man., mech.	Elec.	Mag.	42	Unitized frame
	Squire 8	G	599	8	20.32	Cushioned shaft & belt to transaxle	Stick & clutch	Man., mech.	Elec.	Mag.	42	3-blade cutter deck
Rugg	5088E	L	600	7	16.7	Transaxle	Stick & clutch	Man., mech.	Elec.	Man.	32	Fiberglass hood and fenders
Sears, Roebuck	Super 12 Hydro-Trac	G	970	12	27.66	Hydro.	Hyd.	Man., mech.	Elec.	Solid-state	48	Comp.-release start, solid-state ignition
	Super 12	G	780	12	27.66	Transaxle, hi-lo	Stick & clutch	Man., mech.	Elec.	Solid-state	48	
	Suburban 12 (M)	G	640	12	27.66	Transaxle, hi-lo	Stick & clutch	Man., mech.	Elec. or man.	Solid-state	42	Solid-state ignition
	Custom 10XL	G	600	10	23.75	Transaxle	Stick & clutch	Man., mech.	Elec.	Solid-state	38	Lights, padded seat
	Custom 7 (E)	L	550	7	15	Transaxle	Stick & clutch	Man., mech.	Man. opt.	Solid-state	38	Elec. start, lights opt.; size same as 10-hp.
Simplicity	Sovereign 3012	G	973	12	30.16	Gears plus vari-sheave	Stick & clutch, plus vari-speed lever	Man., mech.; hyd. opt.	Elec.	Mag.	48	3 PTOs, cont. traction diff., sync.-bal. eng.
	Landlord 2110	G	797	10	23.94	Gears, plus opt. planetary kit for 6 speeds	Stick & clutch	Man., mech.; hyd. opt.	Elec.	Mag.	42	3 PTOs, cont. traction diff.
	Broadmoor 717	L	599	7	16.79	Belt to two-speed gears	Stick & clutch	Man., mech.	Elec.	Mag.	36	Sync.-bal. eng.
Toro	Suburban 12	G	1,045	12	29.07	Gear & belt	Stick & clutch	Man., mech.	Elec.	Mag.	42	ACR starting
	10	G	965	10	23.9							
	7	L	600	7	16.7	Transaxle	Stick & clutch	Man., mech.	Man., elec. opt.	Mag.	32	Shaft drive
Wheel Horse	Charger 12	G	1,070	12	29.07	Hydro.	Hyd.	Man., mech.	Elec.	Mag.	48	Auto. diff., power transfer, solid-state rect.
	Raider 12	G	950	12	29.07	Gears	Stick & clutch	Man., mech.	Elec.	Mag.	48	
	Charger 9 Raider 9	G	980 860	9 9	22.97 22.97	Hydro., gears	Hydro., stick & clutch	Man.	Elec.	Solid-state	48	Auto. diff.
	Commando 8	G	750	8	23.75	Gear	Stick & clutch	Man.	Elec.	Mag.	36	Foam seat back rest
	Commando 6	L	640	6	14.1	Gear	Stick & clutch	Man.	Elec.	Mag.	32	Dial cutter-height control
	Ranger	L	590	6	13.55	Gear, Uni-drive	Stick & clutch	Man., mech.	Elec. or man.	Mag.	32	2-year warranty

N.A.—not available *Breakerless cap discharge

short. It will provide all the torque the traction will hold.

Some of the big ones, like the Bolens 12½ hp., Deere's 140, DeVere's two-wheel 10-hp., Engineering Products' Power King, and Graveley's 424 are capable grounds-keeping machines. The

[Continued on page 194]

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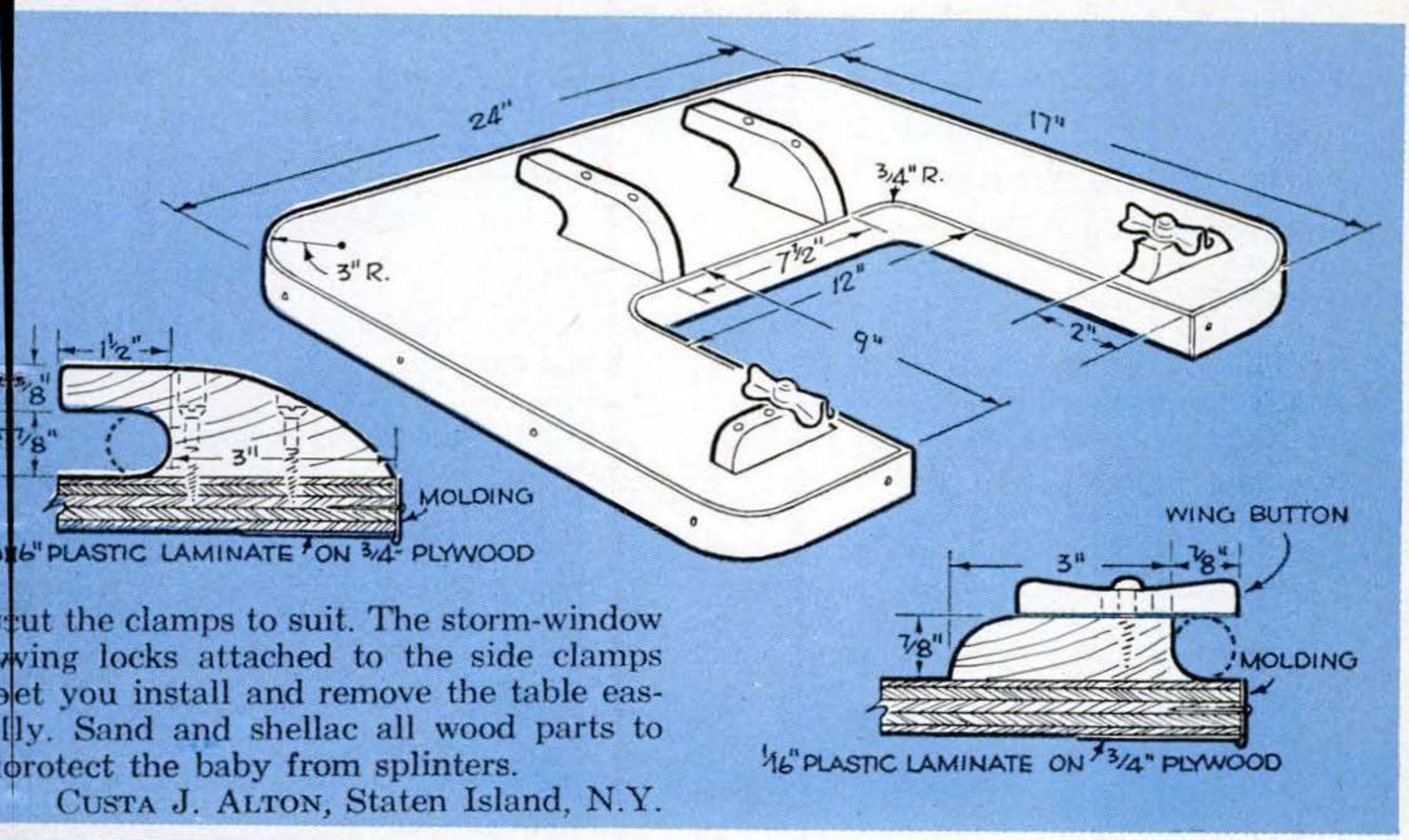
Unusual Things to Make



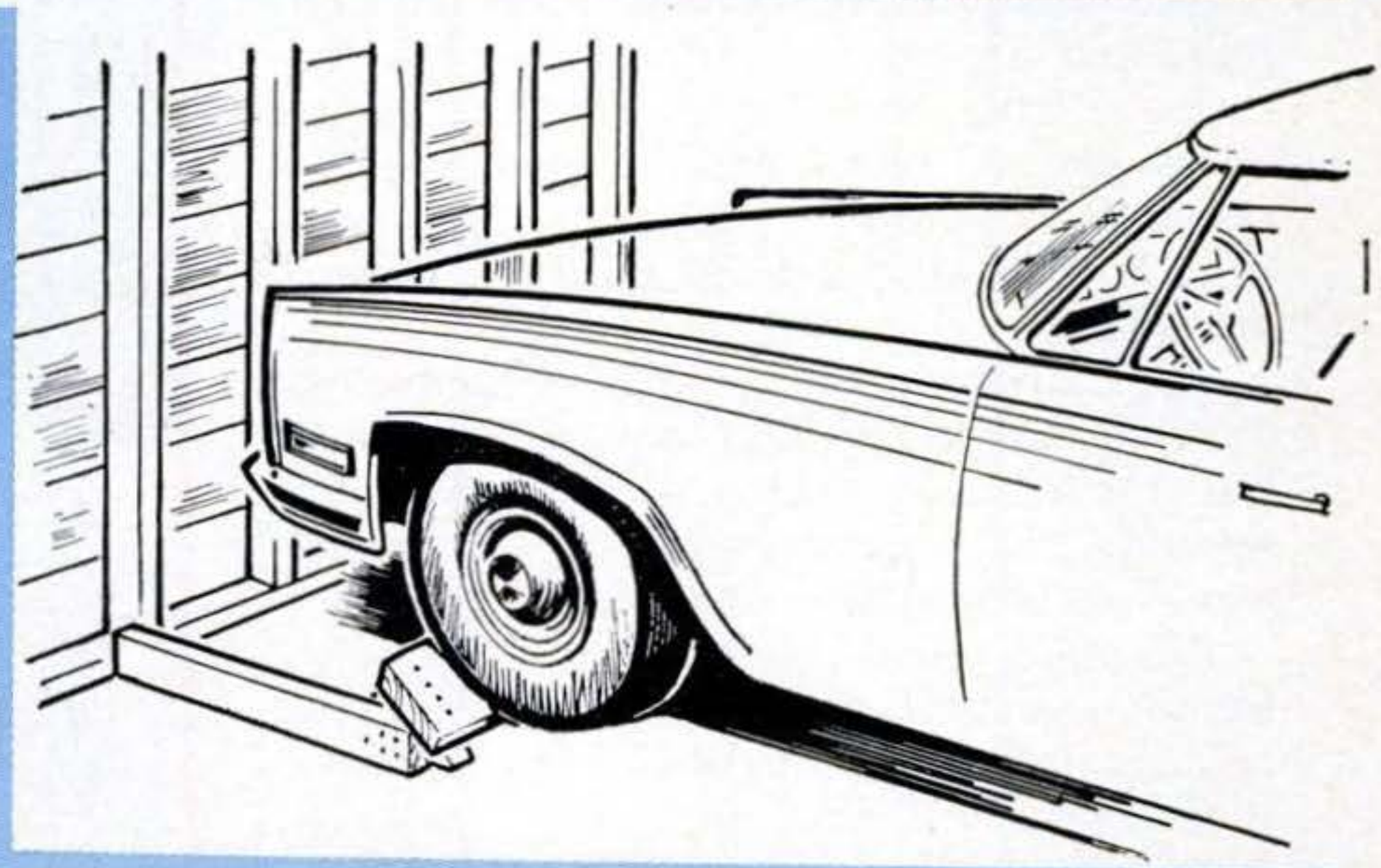
cut the clamps to suit. The storm-window wing locks attached to the side clamps let you install and remove the table easily. Sand and shellac all wood parts to protect the baby from splinters.

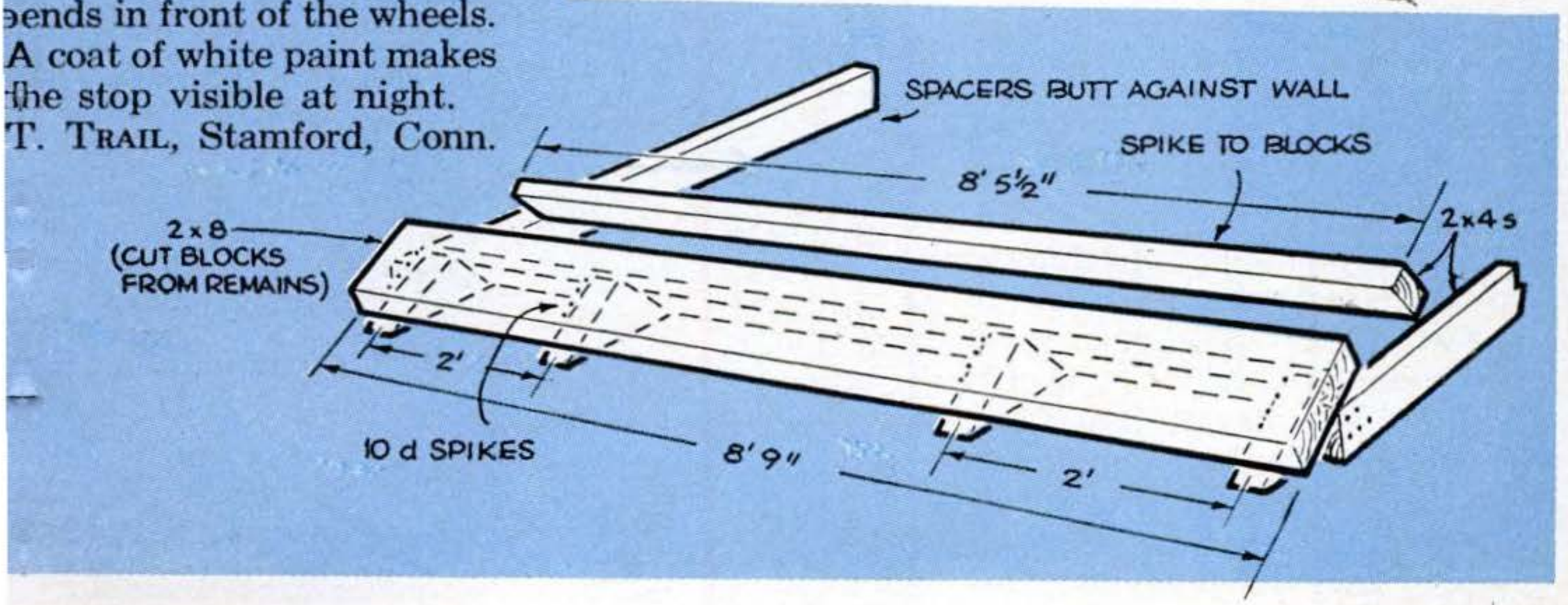
CUSTA J. ALTON, Staten Island, N.Y.

CAR STOP

This inexpensive wheel stop prevents damage to the rear wall of your garage. It's removable when you want to sweep the floor or use the garage for other activities. You'll need a two-by-eight and several two-by-fours. The length of the side pieces depends on how far your bumper extends in front of the wheels. A coat of white paint makes the stop visible at night.

T. TRAIL, Stamford, Conn.





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Gus Has a Trick Up

When the big fire truck quit, it took all of Gus's mechanical savvy—plus a strange fact of science—to find the answer

By MARTIN BUNN

A low-pitched growl of the siren rose to a shattering scream. "Fire!" exclaimed Stan Hicks. He hurried through the open door of the Model Garage and looked down the street toward the firehouse. Gus Wilson snapped a look at the clock on the wall. He waited 30 seconds. The usual roar of exhaust from the big pumper truck rolling into the street was missing.

"Trouble, Stan," barked Gus to his helper as he vaulted into the seat of the wrecker. "Let's go!"

As Gus pulled up, a crew of coated and helmeted firemen was trying to push the massive truck into the street. The spare truck, parked behind the stalled pumper because of station remodeling, was running but couldn't get out until the pumper moved.

"Get a hook on it, Stan," ordered Gus. With a quick cut and backward sweep Gus racked the wrecker into position. In seconds, the pumper was dragged to the street and the spare truck roared out.

"Thanks, Gus." Chief Mal Maloney, a big man with a jaw like a bulldog, jumped heavily from the seat of the stricken vehicle. "She wouldn't turn over. Sounded like it was locked up solid."

Gus nodded and surveyed the traffic jam the truck was causing and the stiff incline of the station ramp. "I can't push it back in. We'd better try to start it."

Before Gus could get his tools, a high-pitched voice emerged from the gathering crowd. "Gus Wilson, you're responsible for this!" A black felt hat of the Harding era bobbed toward Gus and Maloney. Bouncing along under it, arms waving and eyes snapping through steel-rimmed spectacles, was Silas Barnstable. "Wilson, you're the one who recommended that the city buy this—this lemon truck shouted Silas. "I'm on the Fire Commi sion. We'll sue you." Silas gestured the direction the spare truck had take "My shed's burning down. I'll sue yo for that, too."

"It isn't, by any chance," said Chi Maloney, "the shed the City Engine condemned last year, is it, Mr. Bar stable?"

"Makes no difference what it is, M Smart-Aleck Fire Chief. You fello

ILLUSTRATION BY RAY QUIGLEY

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His Sleeve

have neglected this equipment and we'll just see who's so smart when the commission investigates this truck breakdown." Silas scurried toward his car.

Swallowing his irritation at Silas, Gus turned his thoughts to the pumper. The multitude of brilliantly flashing and rotating warning lights testified to the good condition of the battery. A bad starter was a possibility, but the nature of the heavy-duty equipment and the check-out at each crew change suggested against it.

"Open the hood, Mal," said Gus. "I'll get some tools from the truck."

Gus spun out one spark plug from each dual-ignition cylinder. He examined each plug. With six plugs on the fender beside him he looked up at a fireman who had climbed into the driver's seat. "Bump the switch," Gus told him. "Just turn it over easy."

The starter grunted briefly. Gus ducked as a gush of water spurted from one of the plug holes. The driver cranked it again. A few more drops spattered out and the engine spun freely. Gus ran the plugs back in and signaled the fireman. "Start it up and get it back in the firehouse as easy as you can."

"Water lock above a piston, eh?" said the Chief. "Could be a head gasket."

Gus shrugged. "Maybe—or a cracked sleeve or cracked head."

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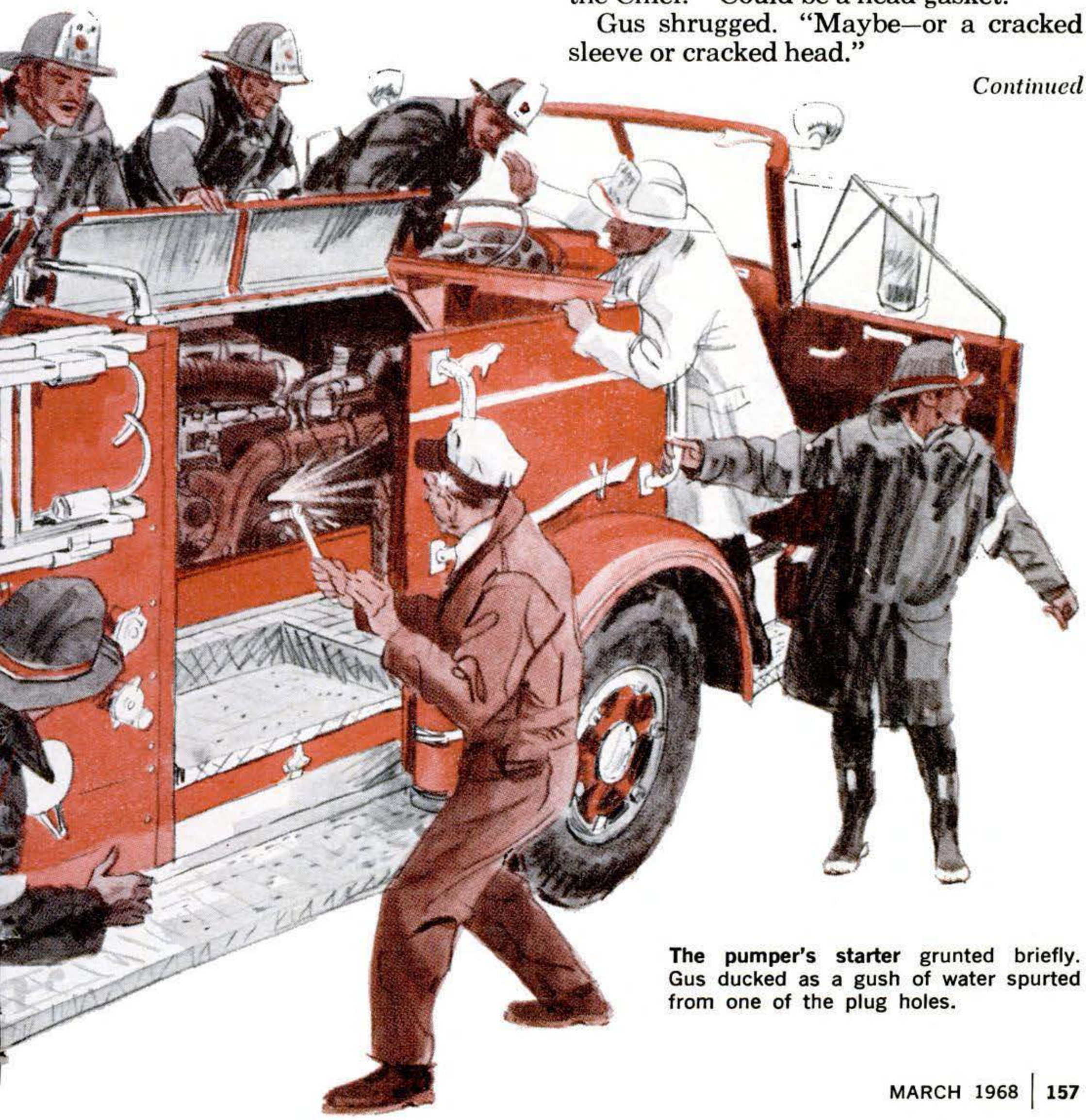

The pumper's starter grunted briefly. Gus ducked as a gush of water spurted from one of the plug holes.

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The Chief glanced back at the station mechanics already at work on the engine. "We'll get her apart by tomorrow morning. "I'd appreciate it if you took a look at what we find."

The next morning Gus stood with the Chief and his mechanics, inspecting the parts of the disassembled pumper engine. The engine was over 800 cubic inches and, typical of such engines, had wet-type cylinder sleeves, removable from the block. The six sleeves were now lined up on the workbench.

"Someone left a half-hour on the meter."

"Here's where the water got in," said Chief Maloney, pointing to a tiny pinhole in one of the sleeves. "But I can't understand the corrosion on these sleeves. The Water Department checks out radiator water every couple of weeks."

Gus peered thoughtfully at the peculiar metal damage on the outer walls of the cylinders. The metal appeared to be eaten away in honeycomb patterns in irregular blotches. On the sleeve that had leaked, there was a pin-size hole to the inside running surface.

"Another thing," said the Chief, "one sleeve isn't corroded at all."

Before Gus could answer, the firehouse door opened and Silas Barnstable came bustling in, tailed by several other members of the Fire Commission. Mayor Barnes, a pink-cheeked, balding man, nodded at Gus. Doc Wilder shook hands with both Gus and Chief Maloney. Mac Billings, a local attorney with a florid face and flowing hair, smiled amiably. Dawson Blake, head of the Technical School science department, came at the end of the parade.

"Caught you at it, didn't we?" croaked Silas. "Cooking up some cock-and-bull excuse for this truck falling apart." His eyes fell on the cylinder sleeves. "Just as I thought. Rusted to pieces from neglect. Plain foolishness."

The cords bulged in Chief Maloney's neck.

"Now, Silas," admonished the Mayor.

Silas was bent over, squinting at the honeycombed holes in the metal. "The material is defective, too, Gus Wilson. Let's see you get out of that."

Doc Wilder examined the sleeves curiously. "Almost seems to stem from an organic problem. Can you have termites in a fire truck?"

"I think we should investigate the warranty aspects," advised Attorney Billings.

"And I think you should investigate the gasoline you're using in this truck," said Gus firmly

"Now see here." Silas straightened up and bristled. "I own the company that sells the city gas, and it's good gas. Perfectly good enough for trucks, anyway. I use it in my own car."

"But your car isn't a fire pumper, Silas," said Gus.

"What's the gasoline got to do with corrosion in the water jacket?" asked Mayor Barnes.

"It's not really corrosion, Mayor," Gus explained. "When the pumper is working hard at a fire it's pulling almost full throttle, sometimes for several hours."

Mal nodded. "That's true."

"It's like using cheap gas in your car," Gus went on. "There, you just get a pinging when you step down hard. Here, the pinging is continuous and it sets up vibrations in the cylinder walls. In some spots this causes millions of tiny bubbles that form on the water side of the sleeves and they eat away the metal—it's called cavitation erosion."

"Poppycock!" cackled Silas.

"I don't know, Gus," said Mal. "What about the one sleeve that wasn't corroded—or eroded?"

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A Home-Shop Test of Irradiated Wood

New plastic-impregnated wood has color clear through, and lustrous projects are easy—with no finishing

It's as modern as space travel, yet as mellow as an antique. It's irradiated wood, and while you'd have to be a nuclear scientist to create it, any homecraftsman with conventional tools can have fun creating with it. Besides a pile of multicolored sawdust with an odor that makes you think you're working Plexiglas, you can end up with an array of projects like those shown above. All were made with this space-age wood and none has had any finish or wax applied. One great advantage of this new material is that you get it with its finish built in.

Checking into how the stuff is produced, I was exposed to words like polymerization, azobisisobutyronitrile (you pronounce it) and up-to-the-minute concepts like nuclear energy and cobalt-60 isotopes.

What emerges from all this Manhattan-Project atmosphere is a wood-plastic alloy. And what you come to understand is that you (that is, *they*) can take most any

Continued

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How to order Novawood

To obtain the Novawood to duplicate these projects, order direct, at prices below, from American Novawood, 2432 Lakeside Dr., Lynchburg, Va. 24501.

Bud vase—maple (walnut 6-01) $1.65
Candlesticks—maple (walnut 6-01) $7.10
Gavel set—maple (black 5-05 or walnut 6-01) $5
Three cups—maple and yellow pine $4.75
Nut bowl—maple (natural with black 5-05 or with walnut 6-01) $11.90
Chessboard: 30"x30" top—maple (walnut 6-01, red 1-01 and yellow 2-03) $25
Adhesive (½ pint) 80¢

NOTE: Woods with numbers are natural maple, colored. Nut-bowl and chessboard kits include adhesive. All prices are postpaid east of Mississippi. For West, add 35¢ per item, except chessboard ($1.50 extra). Package containing all materials listed, plus pumice block, available for $50.

wood, impregnate it to the last and tiniest cell with liquid plastic, and then expose it to gamma radiation from cobalt so that the plastic hardens uniformly throughout. The material isn't radioactive; sawdust and shavings are harmless.

The wood loses none of its natural beauty—in fact, grain is accentuated—and since the liquid plastic can be tinted, effects such as walnut-toned maple, black fir, red beech, and green maple are possible. Whatever the wood or color, you just buff and polish to a lustrous sheen. You needn't fuss with stain, filler, varnish, shellac, lacquer, or wax.

The wood is improved in nearly every other physical respect. It becomes harder, stronger, more resistant to marring and abrasion, and has a substantially lower rate of moisture absorption. It loses out in one respect—nailability.

You can cut joints in it, drill it, glue it, tap it, screw it, dowel it; but you don't nail it. And with screws, you drill a good-size pilot hole for the full length of the screw plus a full-size shank hole. The people who make this particular product, called Novawood, recommend their own adhesive or a phenolformaldehyde resorcinol such as Cascophan LT-68D made by Borden. Both work very well at a temperature around 70 degrees. As I discovered with the chessboard project, a good contact cement is fine for laminating. I applied it to the base (a cut-out from a solid-core door, but plywood will serve) and to the squares, then tapped each square down with a rubber mallet.

Be prepared for one thing, should you order some Novawood. Except for weight and color, the raw, unpolished product you'll receive won't seem too unusual. The difference between it and the wood you're used to will only become obvious when you start cutting, and when you get to finishing. Also, as you might expect, cost per board foot is much more than you would pay for the same wood untreated. For POPULAR SCIENCE readers, the company has packaged the materials needed for each of the projects shown here. If you want prices on other quanti-

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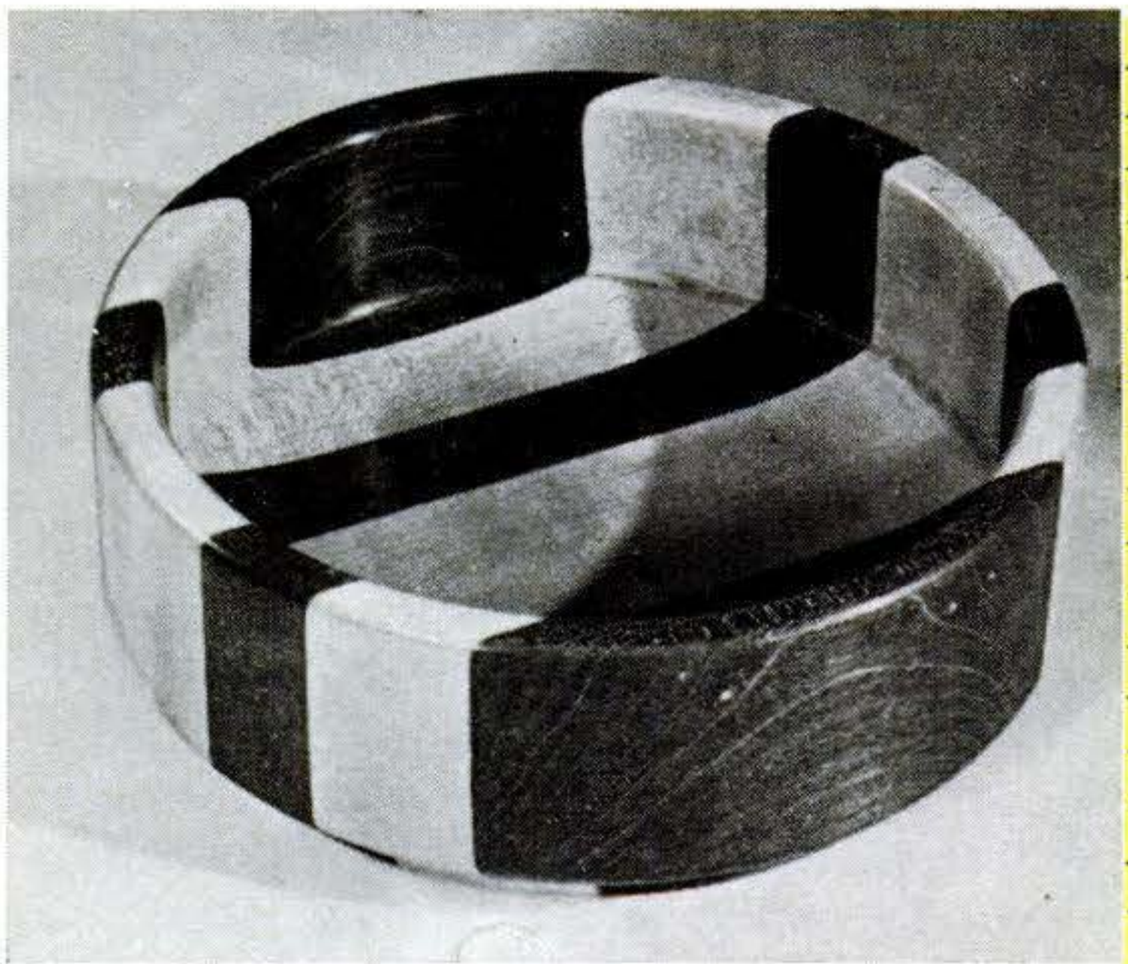

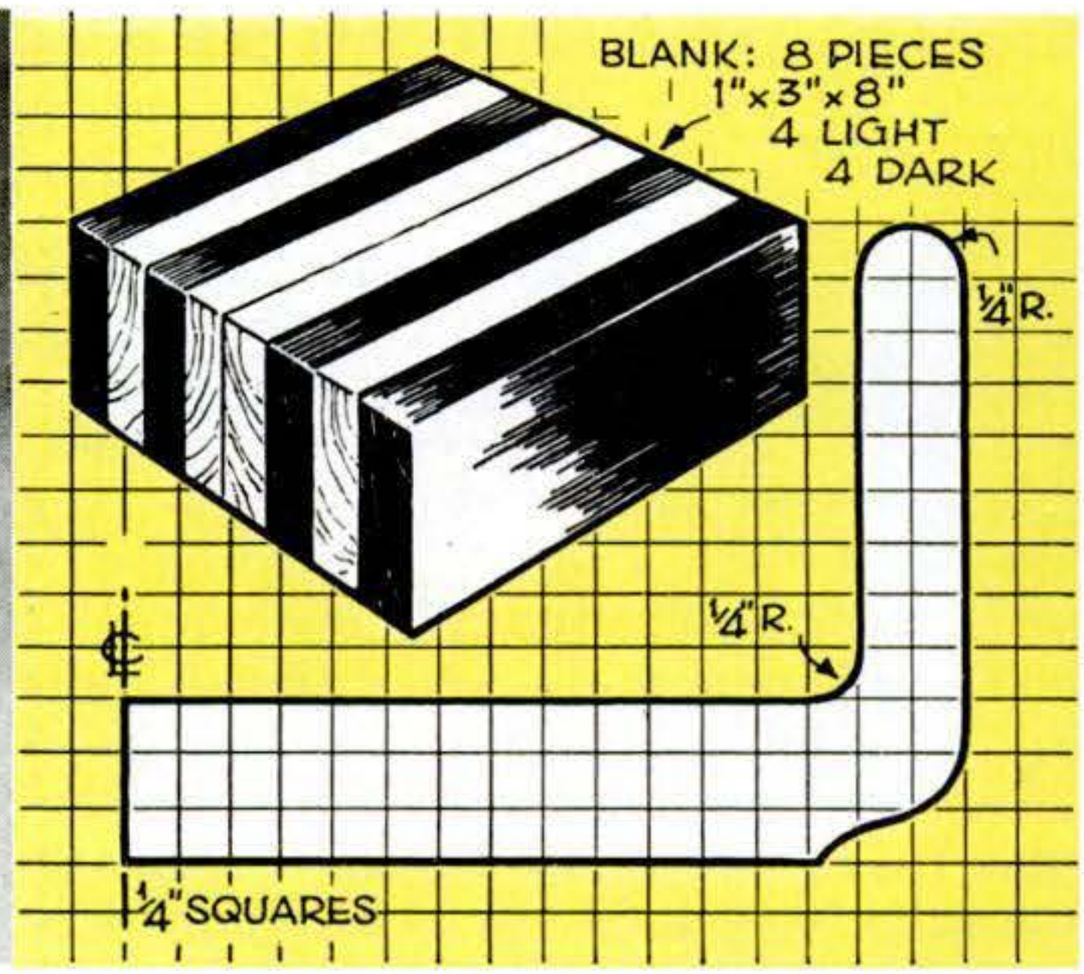

Nut-bowl blank is glued up in standard fashion, except that special Novawood adhesive is used. Face-glue inch-thick pieces of contrasting woods (such as maple and walnut) and clamp them. Let dry overnight, then cut block into a rough disk on the bandsaw before mounting it on lathe faceplate.

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new Surfer is quality in depth

...19 feet in length!*

We could have screwed our 3-position bucket seats to the floor instead of using bolts plus special gripper nuts. But we didn't.

We could have offered our convertible top and front tonneau cover as optional instead of standard equipment, neatly stowed to protect against dirt and damage. But we didn't.

We could have supplied plated, screwed-on deck hardware as optional equipment, instead of including all deck hardware of non-corrosive alloy, through-bolted, as standard equipment. But we didn't.

We could have scraped by with less than Johnson-dependable power — 210 hp strong in a V-8, 4-cycle stern drive — with easy access cover, electric power tilt, full 90° steering arc and one-hand Electramatic throttle and shift control. But we didn't.

We could have saved by eliminating all that storage space in bow, side and glove compartments, or by not padding side and glove compartments for your valuables. But we didn't.

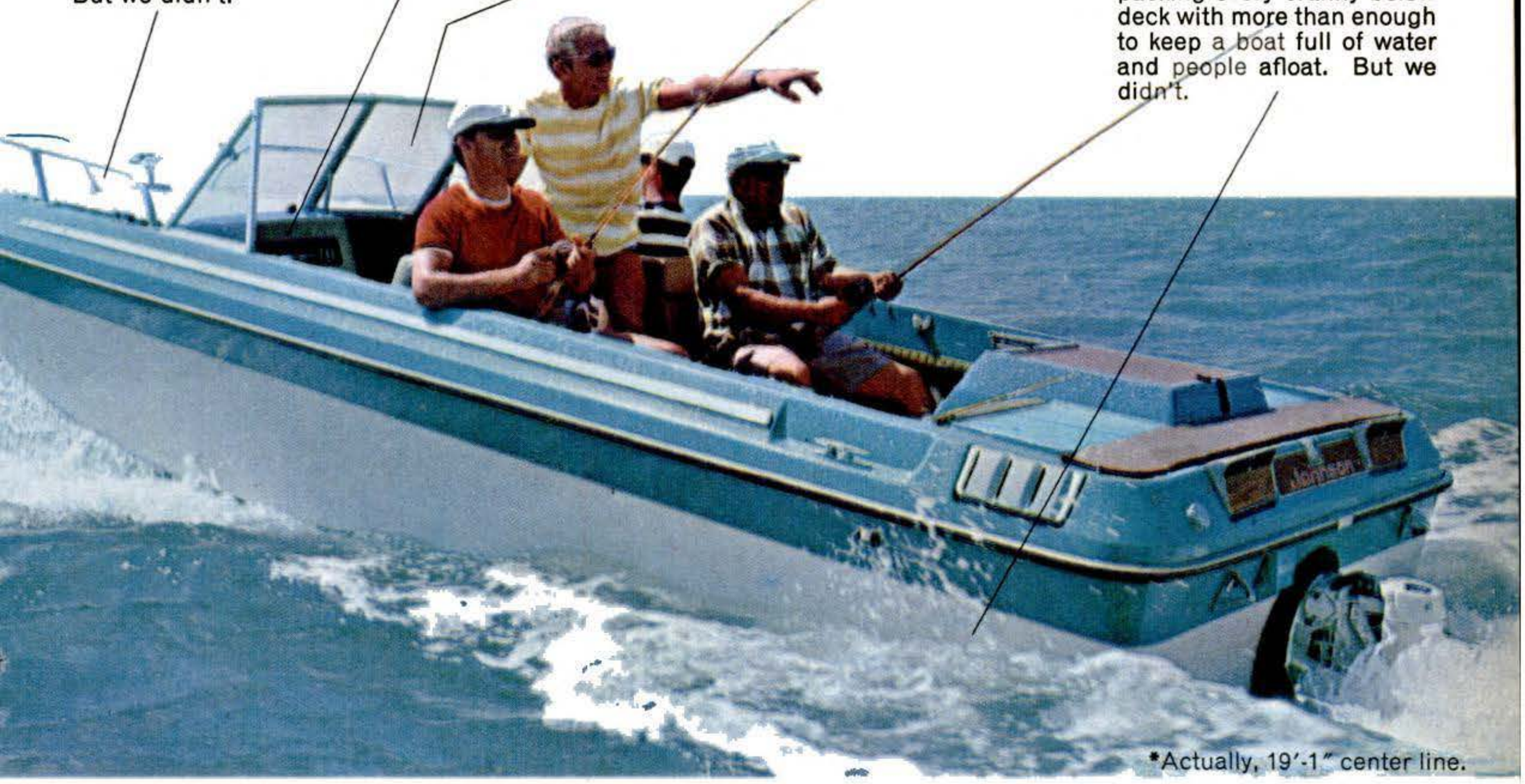
We could have designed a conventional pointed-nosed hull instead of our Sea-Foil hull with its twin-arch contours that put water to work for our soft, smooth, level, dry ride. But we didn't.

We could have settled for a plastic windshield instead of specifying tempered, tinted safety glass in heavy die-cast aluminum brackets bolted to the deck support, with hinged center section for access to bow. But we didn't.

We could have offered instrumentation as an accessory instead of making it standard: tach, speedometer, ammeter, fuel gauge, heat and oil warning lights—plus control switches, a cigaret lighter and electric horn. Plus a new indicator that shows drive direction before you take off. But we didn't.

We could have devised a conventional floor plan for a conventional hull, instead of our square, open bow that creates 96 sq. ft. of space for 9 passengers to spread out in. But we didn't.

We could have skimped on flotation, instead of pressure-packing every cranny below deck with more than enough to keep a boat full of water and people afloat. But we didn't.



*Actually, 19′-1″ center line.

We could have put a lot less built-in value into our Johnson Boats—especially since many of those built-in values don't even show. **But we didn't!**

See all four new Johnson Boats — 14′-9″ to 19′-1″ — at your dealer's now, or write for free catalog. Johnson Motors, Waukegan, Ill. 60085, Dept. PS-B38.

Johnson Boats

FIRST IN DEPENDABILITY

Division Outboard Marine Corporation

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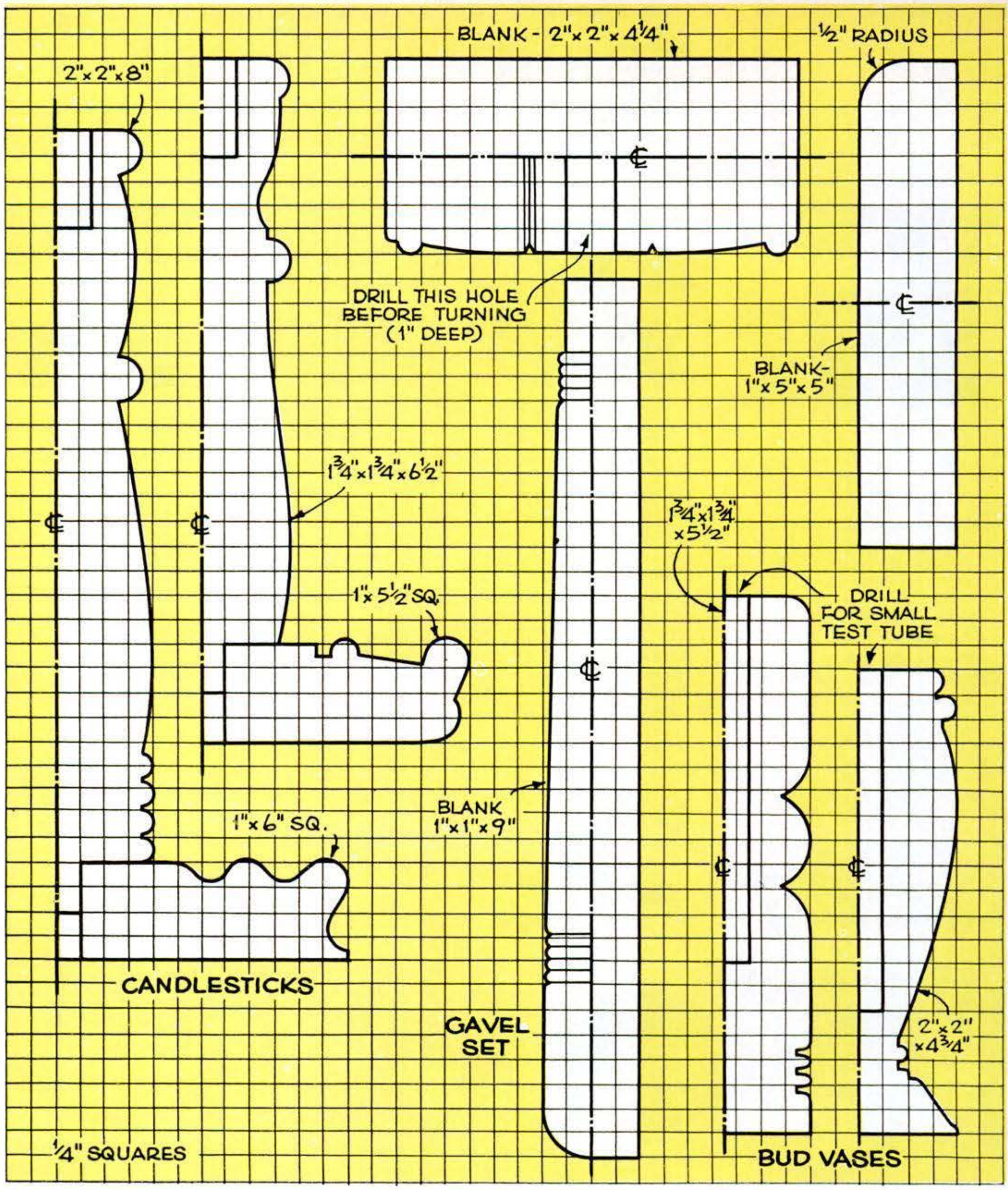

ties for projects of your own, write them direct at the address on page 168.

How about cutting? Well, you can't expect that your tools will be as sharp after biting into this material as they would be after cutting a similar amount of untreated pine. You are working a hard, dense product, and tools will dull faster—but not to the point of discouragement. Whenever you can, work with carbide-tipped tools. My 55-tooth carbide-tipped circular saw had about six months of hard use before I tackled Novawood and is still doing well after piling up lots of irradiated sawdust.

Tests with regular blades indicate that any style will work if you just accept faster dulling. For general cutting, I'd select a clean, sharp crosscut blade and use it with maximum projection and a very slow feed. Plastic residue will accumulate but it's not difficult to flick off. Heat buildup will accelerate dulling and clogging so you'll be wise to pace all

Continued

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It'd be a big mover on looks alone.

It's domed. It's striped. It's got bulges on its bulges. It's SS 396, boss of the Quick-Size Chevelles. But don't let all the niceties fool you. Underneath, it's got everything you need for your kind of driving. 396 cubic inches, beefed-up shocks and springs, wide oval treads, the whole thing. With credentials like that, you could get along nicely without the glittering goodies. You *could,* but why play it down when you're living it up?

Chevelle SS 396

Be Smart. Be Sure. Buy now at your Chevrolet dealer's. CHEVROLET

MARK OF EXCELLENCE

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ns is a gearshift, clutch, and a throttle.

(It's the all-in-one lever that lets you go forward and back, fast or slow . . . without clutching!)

The 12 hp MF 12 with Hydra Speed Drive is the no-clutch, no-shift garden tractor. A touch of the Hydra Speed Lever and you do what you want instantly. Maneuvering a garden tractor was never as simple, easier, or more fun. What's more, the big 42-in. mower can be attached in minutes.

Mow close to walls and trees with your MF 12. And with MF Hydra Speed Control you can inch in and out of tight spots, then move away at full speed. There are dozens of easy-to-handle attachments for every gardening need.

If you prefer a low-cost standard transmission garden tractor, check out the 10 hp MF 10. MF Variable Speed Drive gives you five speeds in each of four forward gears and one reverse. For snow removal, use the 36-in. blower or the 42-in. dozer blade. Both fit the MF 12.

Choose the MF Garden Tractor that suits *your* fancy—the MF 10 or MF 12

MASSEY-FERGUSON
Massey-Ferguson Inc., Des Moines,

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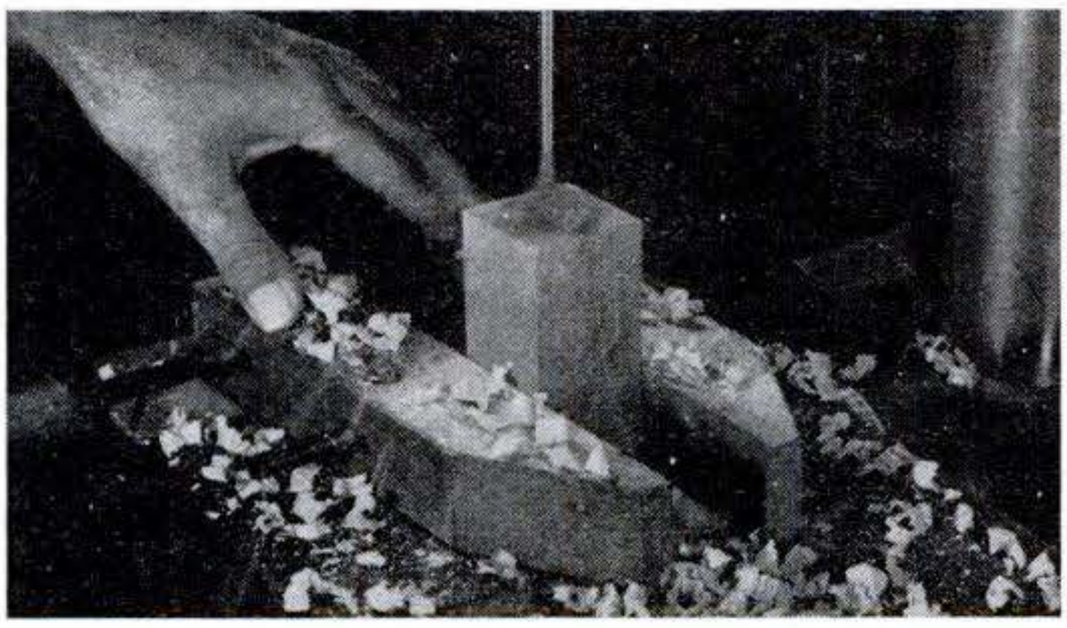
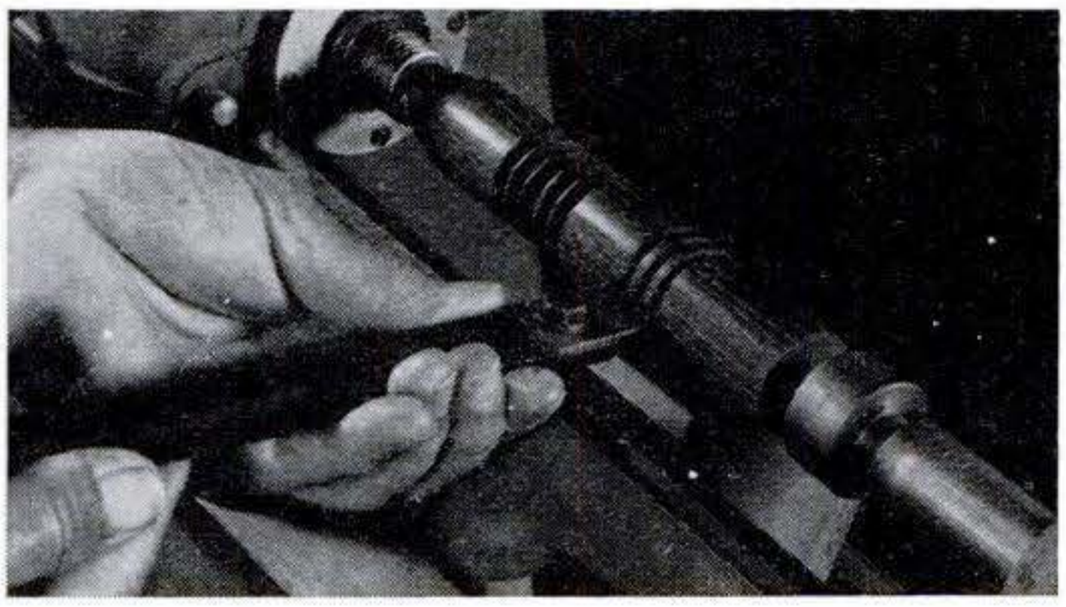
Power-tool tips for working with irradiated wood



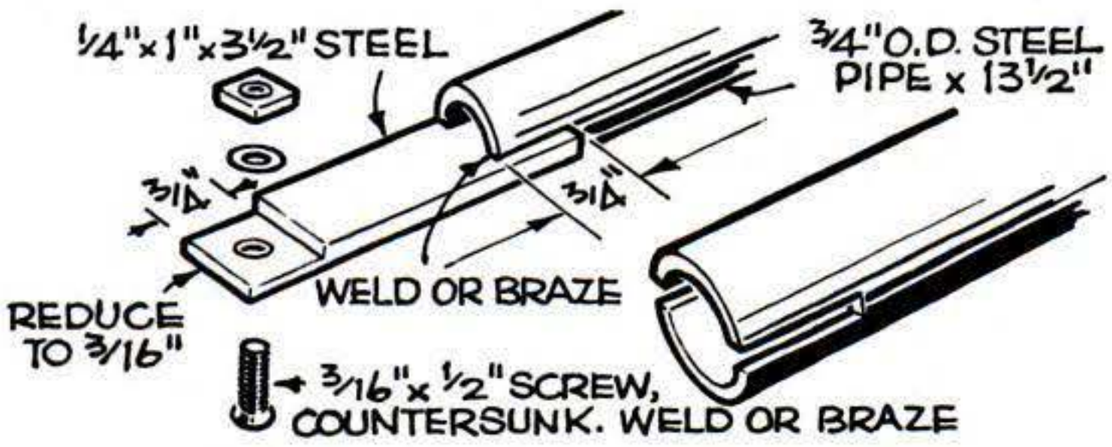
Drilling with spade bit at recommended woodworking speeds produces clean holes quickly. Just keep work clamped securely. Retract the bit frequently to keep it cool—this prevents plastic buildup.

Faceplate turnings go fast, even though you work with a scraping action. Carbide-tipped tools are best, but regular chisels will work fine if you stop operations to sharpen them at frequent intervals.



Molding-head knives can be used to shape fine details without danger of chipping because of the density of the material. Beads and vees come up fast if you keep knives sharp for scraping.

Special tool holder for molding-head knives (photo above) is easily made from steel scraps, as shown below. Rabbet one end of tongue to seat bolted-on knives, secure other end in slotted pipe handle.



your cuts to keep the blade as cool as possible.

Disston makes a special plastic-cutting blade that does a very nice job but it's not one you can buy in the average hardware store, so unless you plan some heavy production work, stick with tools you already own. Start with sharp teeth, hold work firmly, feed slowly, and you'll get a cut that needs only light sanding and some good polishing to finish.

Is jointing difficult? Edge-jointing is easier than surfacing simply because it's usually easier to hold work-on-edge very firmly. No fast passes here or you'll get ripples like you never saw before. Try to stay with a 1/32" depth-of-cut and accept 1/16" as a maximum even though you can cut deeper. Light cuts and slow feeds produce well-burnished edges.

Curve cutting. On the bandsaw, an all-purpose blade that cuts nonferrous metals as well as wood does a good job. But I was also pretty successful with regular wood-cutting blades—if they had a respectable amount of set. Any binding produces heat quickly and thus leads to a lot of plastic accumulation.

In a saber saw, use metal-cutting blades —but not the hacksaw type. Choose those with larger teeth. Of course, the thinner the material you work on, the smaller the teeth can be. You can work on the jigsaw, but avoid small blades unless you are cutting veneer-thick stock.

Drilling. All drilling tools perform satisfactorily at slightly reduced speeds, but I got best results with spade bits at recommended woodworking speeds. You can't hog these cuts and yet you can't be

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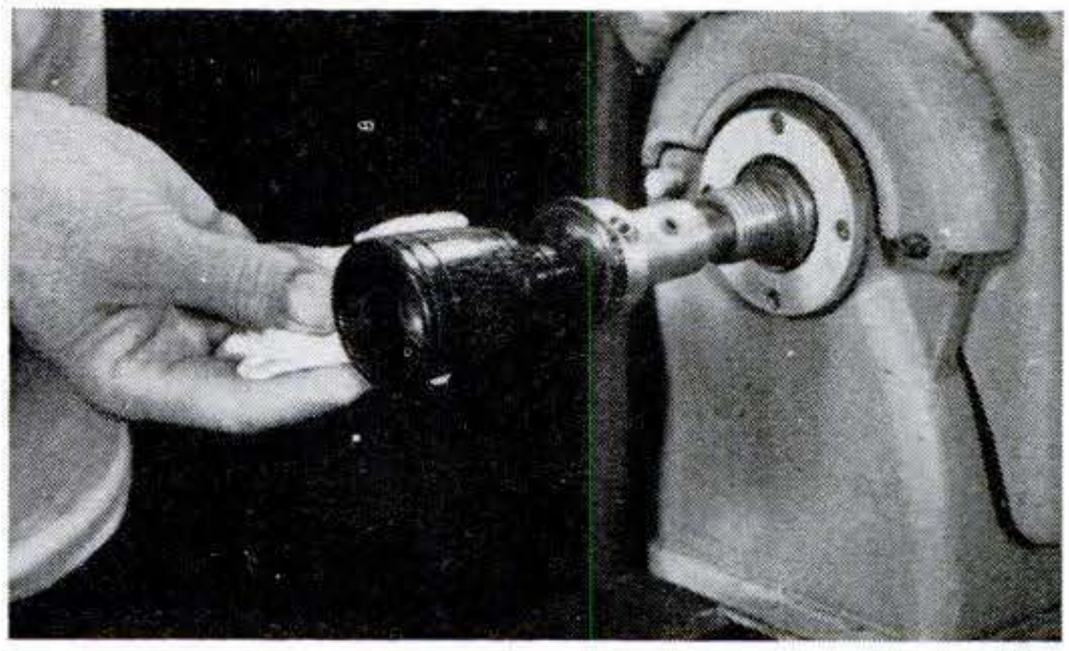

Built-in finish is easiest to achieve on lathe. After working through recommended grit sequence, polish with cloth pad and pumice or rottenstone, generating heat enough to glaze surface plastic.

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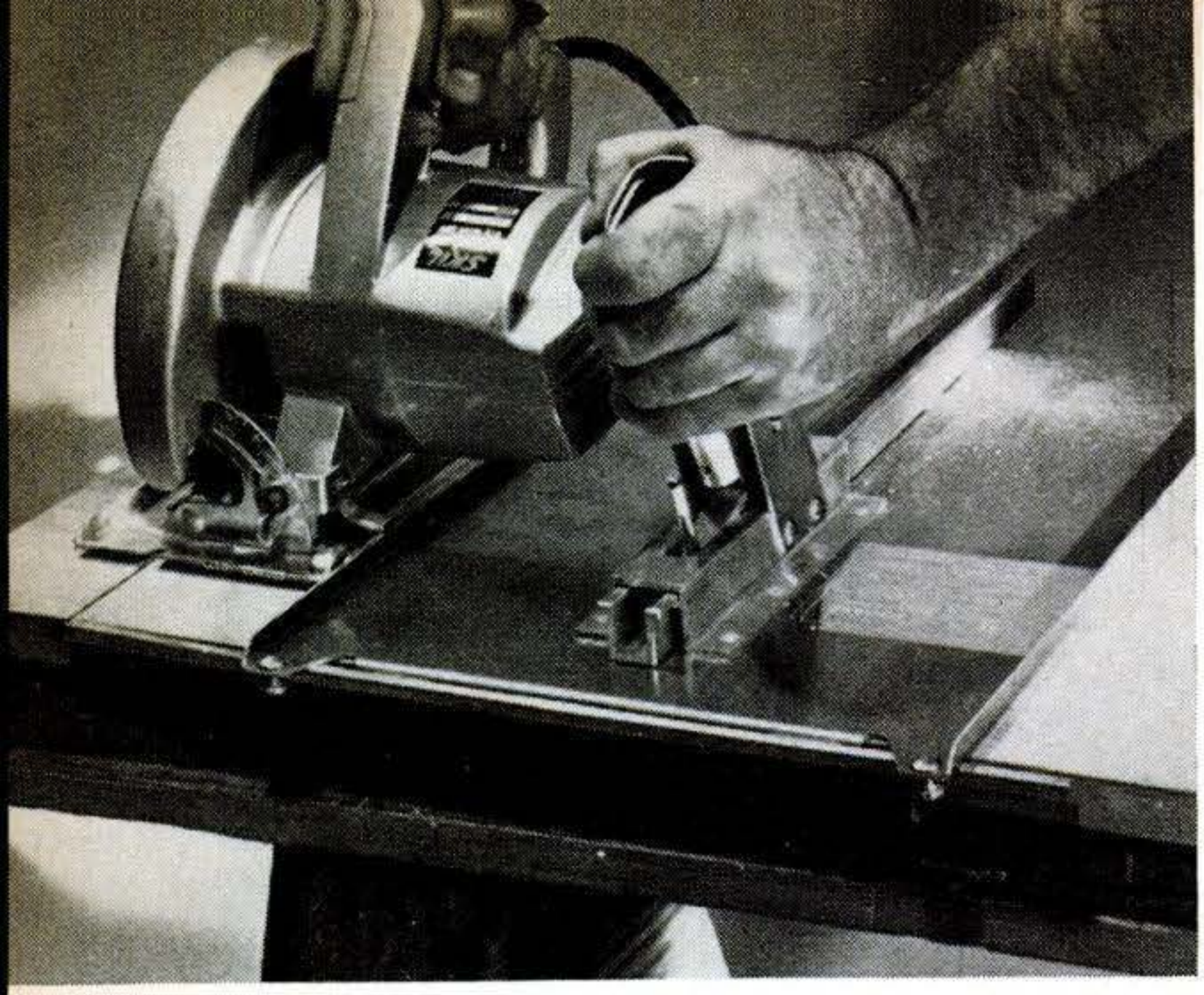
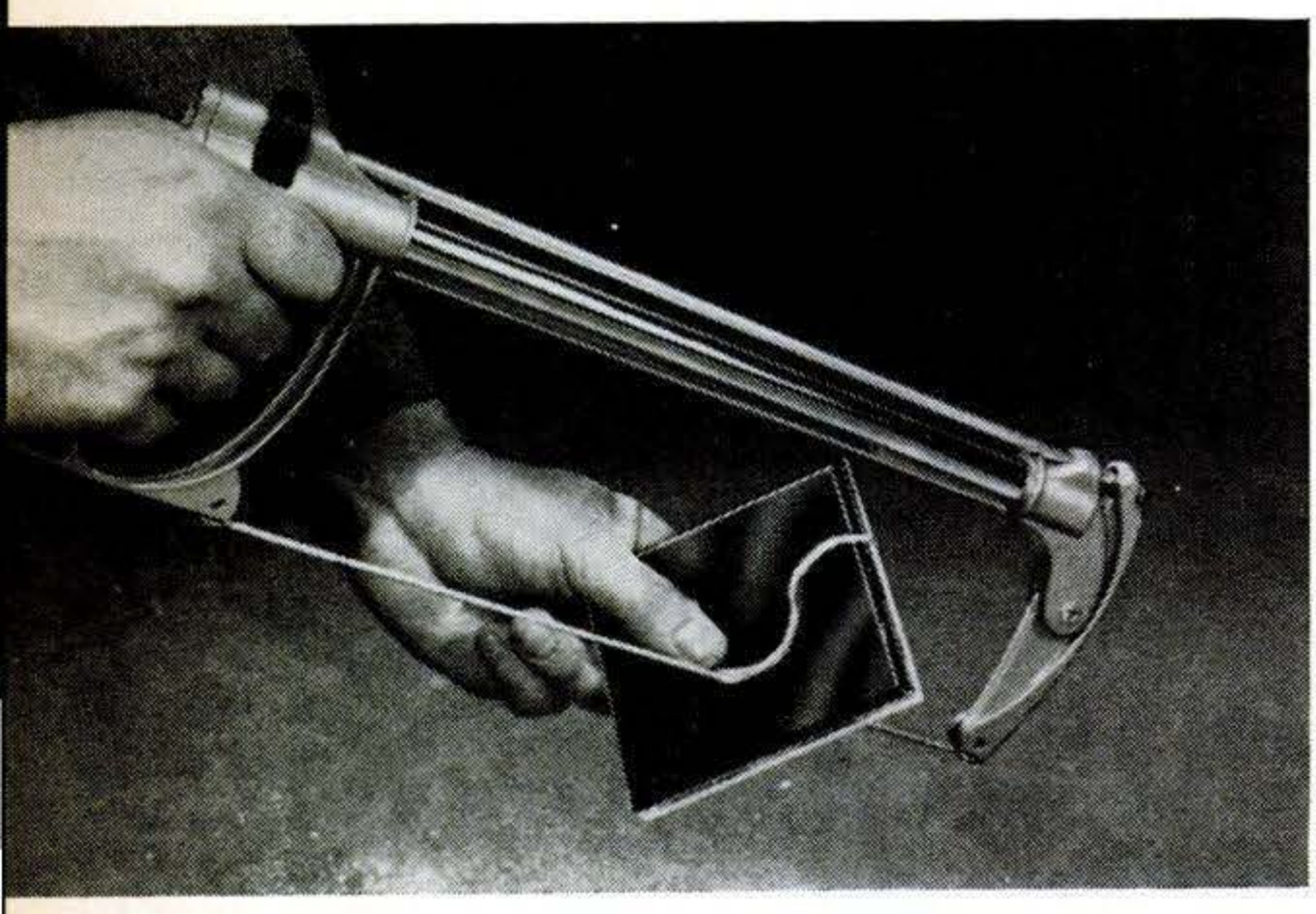


Circular saw guide speeds cutoff work

Cutoff and dado work goes faster with Sure Square saw guide because there's no need for clamps. It's made of lightweight aluminum and grips the edges of the workpiece firmly when the handle is squeezed. Set the pointer bar 1/32 inch less than the shoe offset and the guide is always ready for use with any 6½-inch or smaller saw. Cost: $16 postpaid. Also available with a four-blade dado set for grooves up to 7/16 inch (write for price). Independence Specialties, Box 2987, Philadelphia 19126.



Rod saw cuts through toughest materials

Unusual ability to cut hard materials is claimed for a new rod saw by Remington. The secret: hundreds of tungsten carbide particles permanently bonded to its surface. The blade is 10-inches long and fits standard hacksaw frames. It will cut brick, glass, steel, fiberglass—even ceramic tile (photo, left). Jobs take less time, too, since the saw cuts on both forward and backward stroke. The round shape cuts curves with a short radius, and in any direction. At hardware stores: $2.

Torch kit in a plastic chest

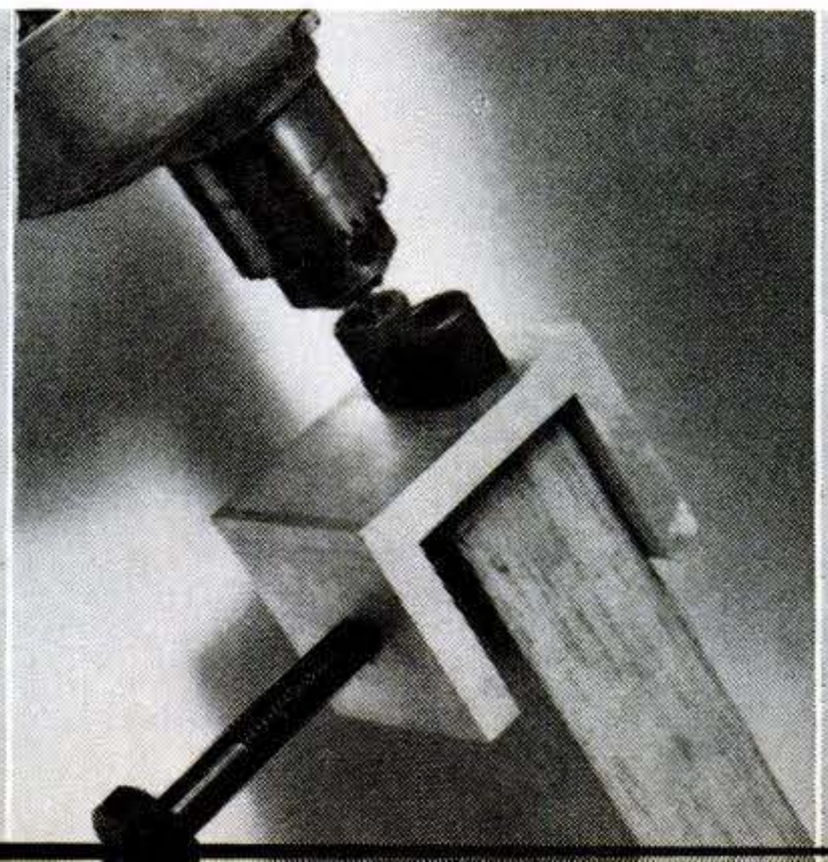
A compact tote kit offered by Turner consists of a burner assembly with pencil-point flame tip, propane fuel tank, all-purpose soldering tip, flame spreader, and spark lighter, all in a styrofoam insert for protection and easy access. The product comes with a guarantee that the maker will rebuild, or replace at no cost. About $11.

Jig speeds doweling jobs

There's no tricky measuring with this jig—you just position stock flush with one edge, clamp, and drill. It's designed for 3/8-inch right-angle or 45-degree doweling on stock up to 1 3/8 inches thick. Frame is aluminum. Can be used to drill one or two holes. $5.95. Chutich Wood Products, 660 Wolf Road, Wheeling, Ill. 60090.

C clamp resets instantly

You can reset this clamp in a fraction of the time it takes with a conventional one because no turning is required. Press the trigger to release the grip on the shaft and move the shaft to the desired position. In six sizes, openings one to four inches, ranging from $1 up to $6. Wing Products, 805 Farmer Ave., Tempe, Ariz. 85281.



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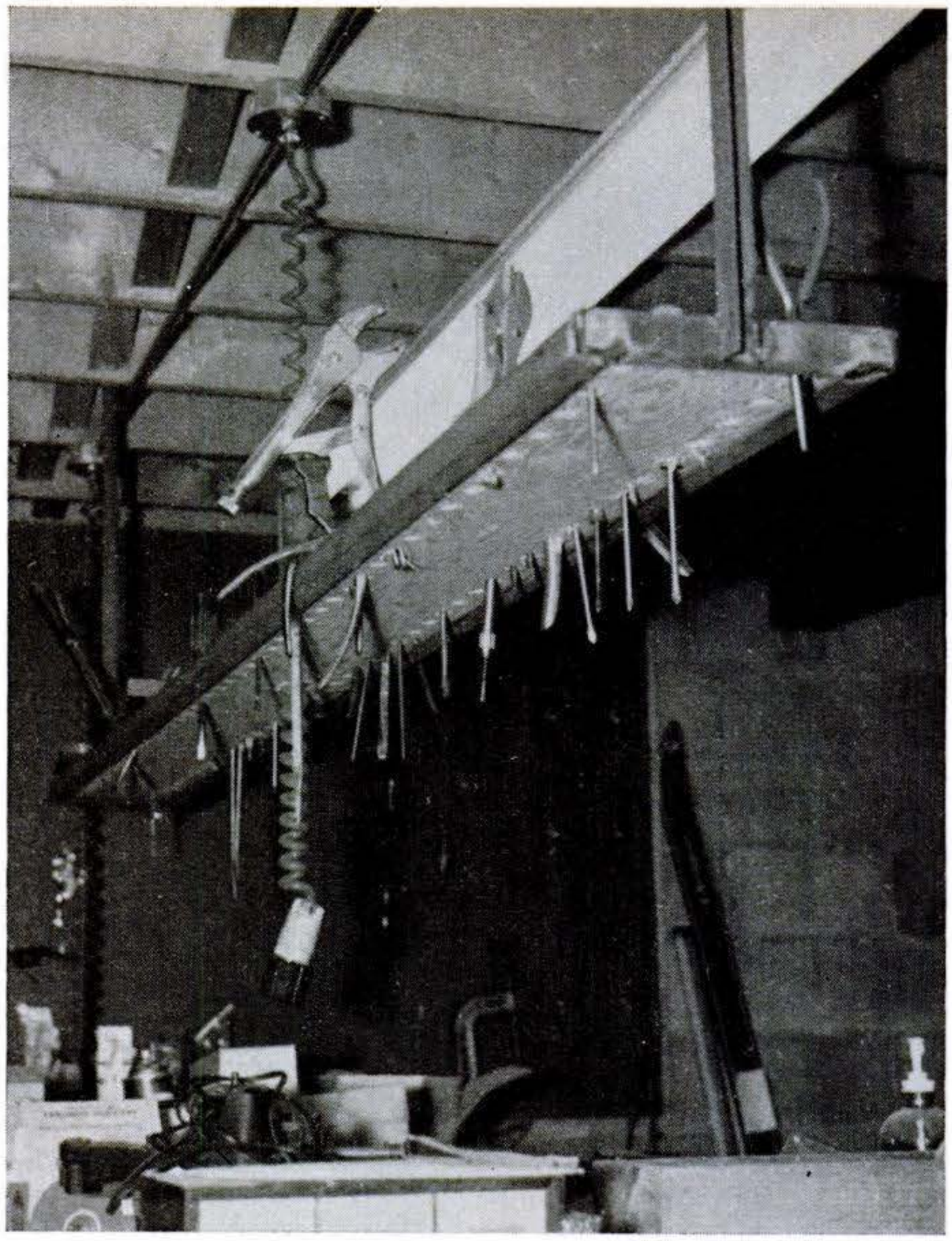
SHORT CUTS AND TIPS

FROM HERE AND THERE

Overhead rack keeps tools in easy reach

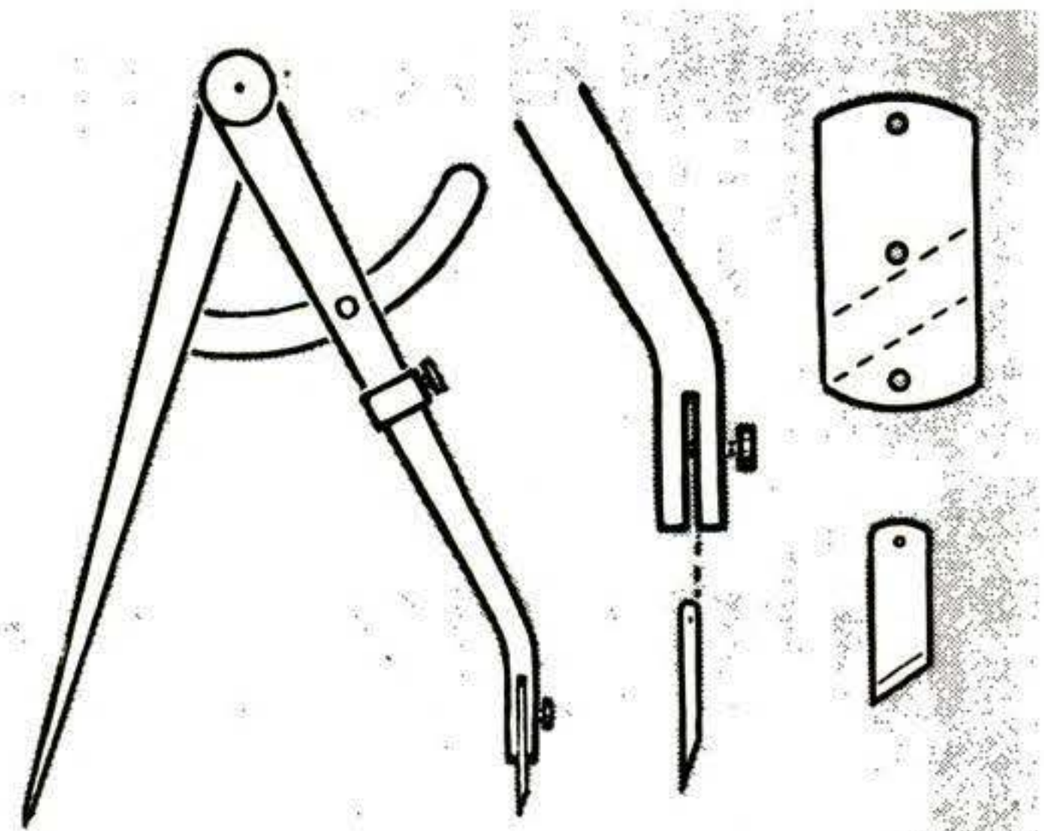
If you can't build a tool rack at the back of your workbench—or the one you have is filled up—you can keep tools organized this way: Drill holes to suit the tools in a piece of ¾″ plywood and use angle iron to reinforce the edges and for hanging. Make sure you hang your rack high enough to avoid hitting your head.

CHARLES STRATTON, Windham, N. H.



Can opener lasts longer if it's kept oiled

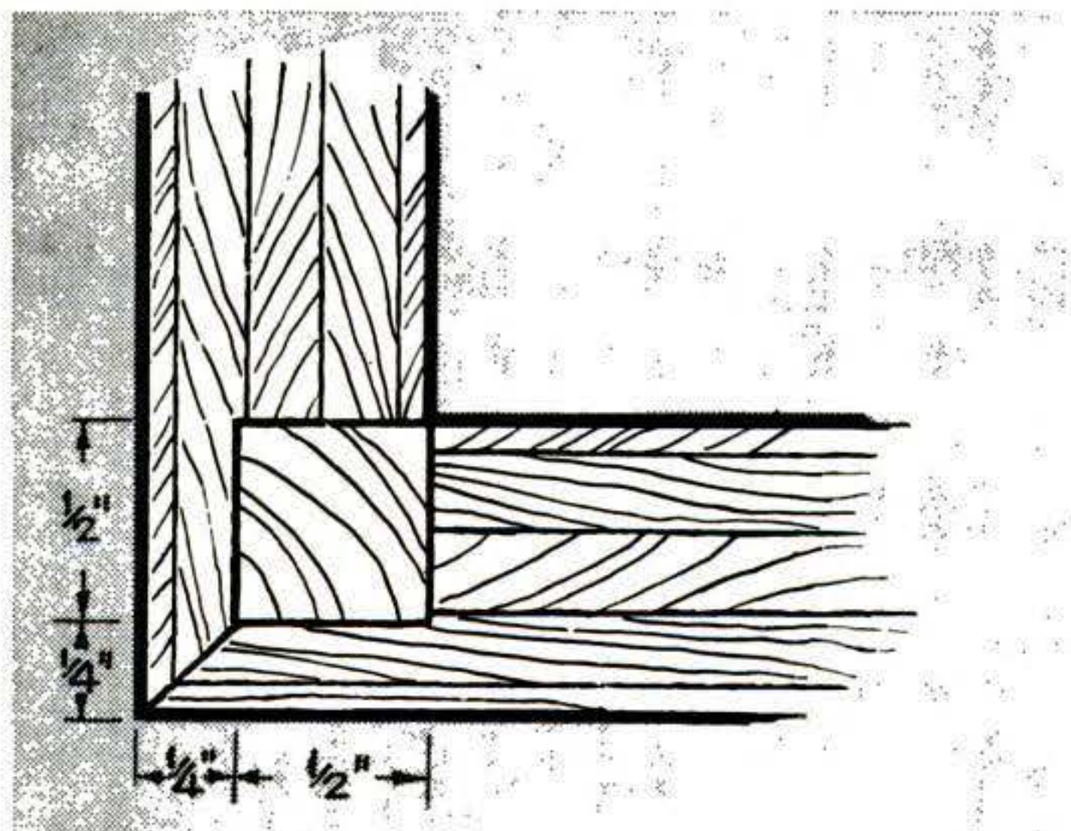
Kitchen can openers should be cleaned periodically for efficiency, and sanitary reasons. Use mineral oil to keep it from rusting; it's nontoxic and won't turn rancid. TED BARBEE, Hawthorne, Nev.



Blade in compass cuts neat gaskets

You can use a compass to make special gaskets. Drill and tap an 8/32 hole in a short rod for the blade-clamping screw. Cut a 1″ slit in one end; bend the other about 20 degrees. Insert a piece of sharpened hacksaw blade in the slit for tough jobs; use razor blades for light work. Wear safety glasses when snapping blades.

PETER LEGON, Malden, Mass.



Fast way to make a strong miter joint

Mitering the corners is one of the best-looking—and weakest—methods of cabinet joinery. But made this way, miters won't pull apart. First cut the ½″-by-½″ grooves in the panels to be joined, *then* make the miter cuts. Use a hardwood for the core, glue it to one panel, and, when dry, assemble and clamp the cabinet.

M. BISSONNETTE, Nova Scotia, Can.

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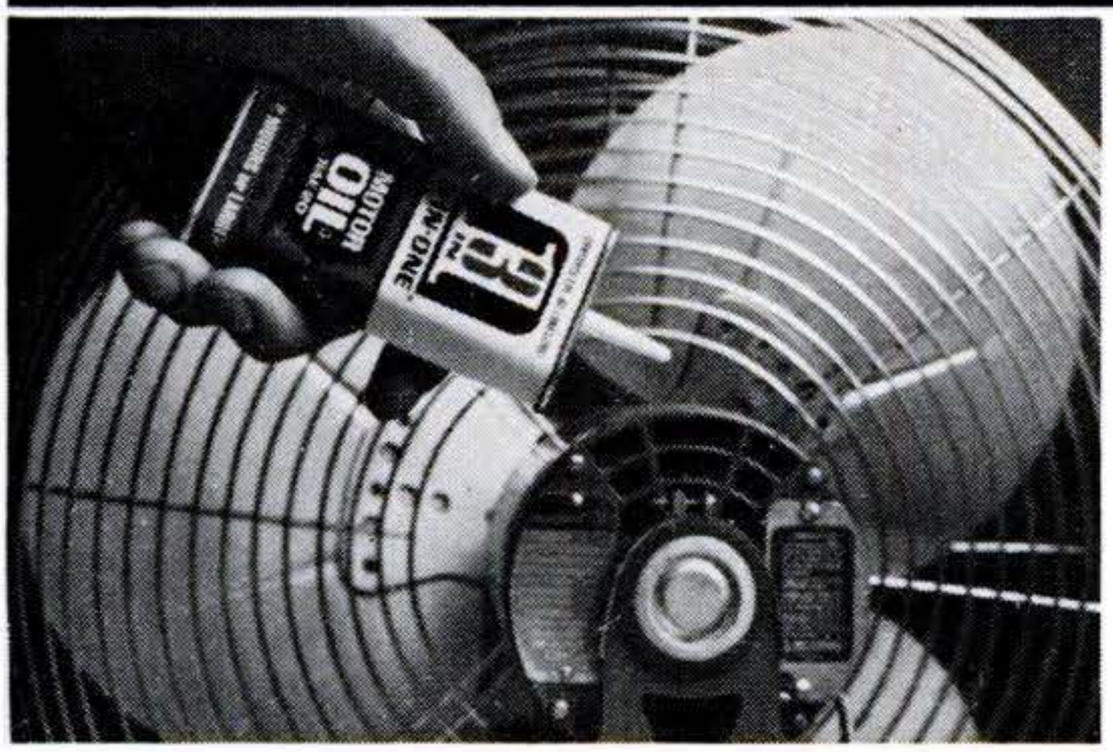
Blowers...to Mowers



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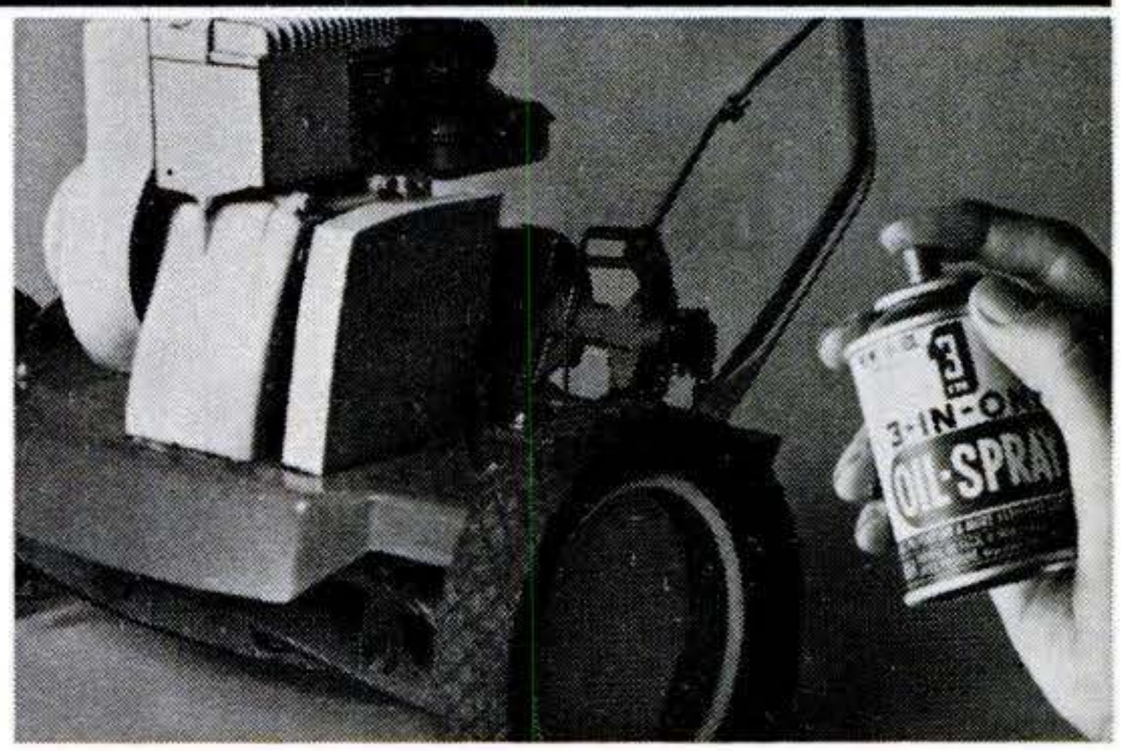

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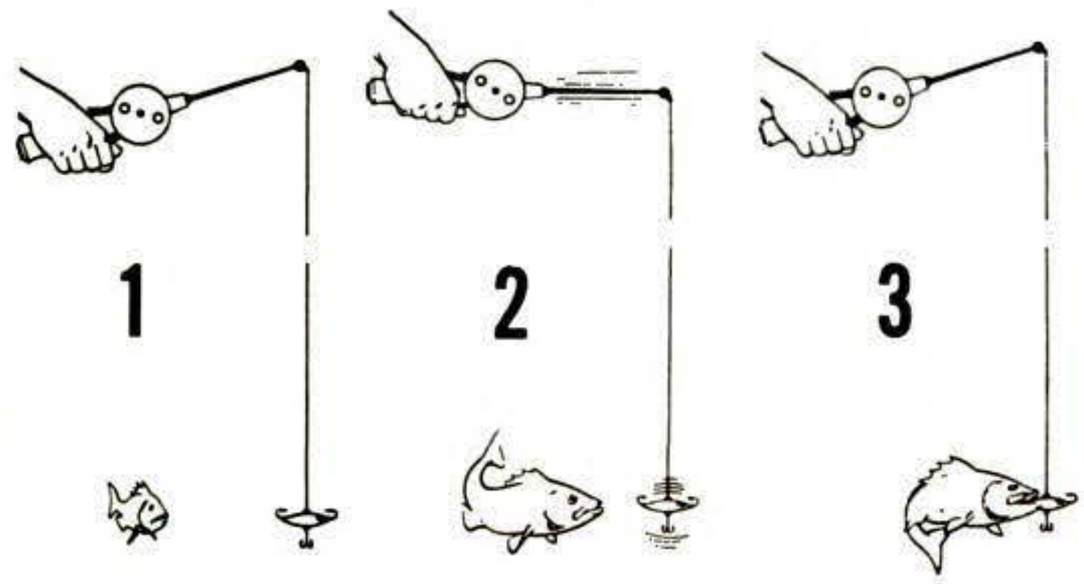
Fishing with a thrumming action

A new Finnish fishing secret is out—"thrumming." Just squeeze the handle of this new rod and bait quivers, exciting game fish into striking. Fish with line vertical (1); alternate squeezing and holding still (2); fish hits the lure as movement stops (3). Thrummer rod and reel, complete with 50 yards of line, $6.95. Normack Corp., Minneapolis, Minn. 55423, sells it here.

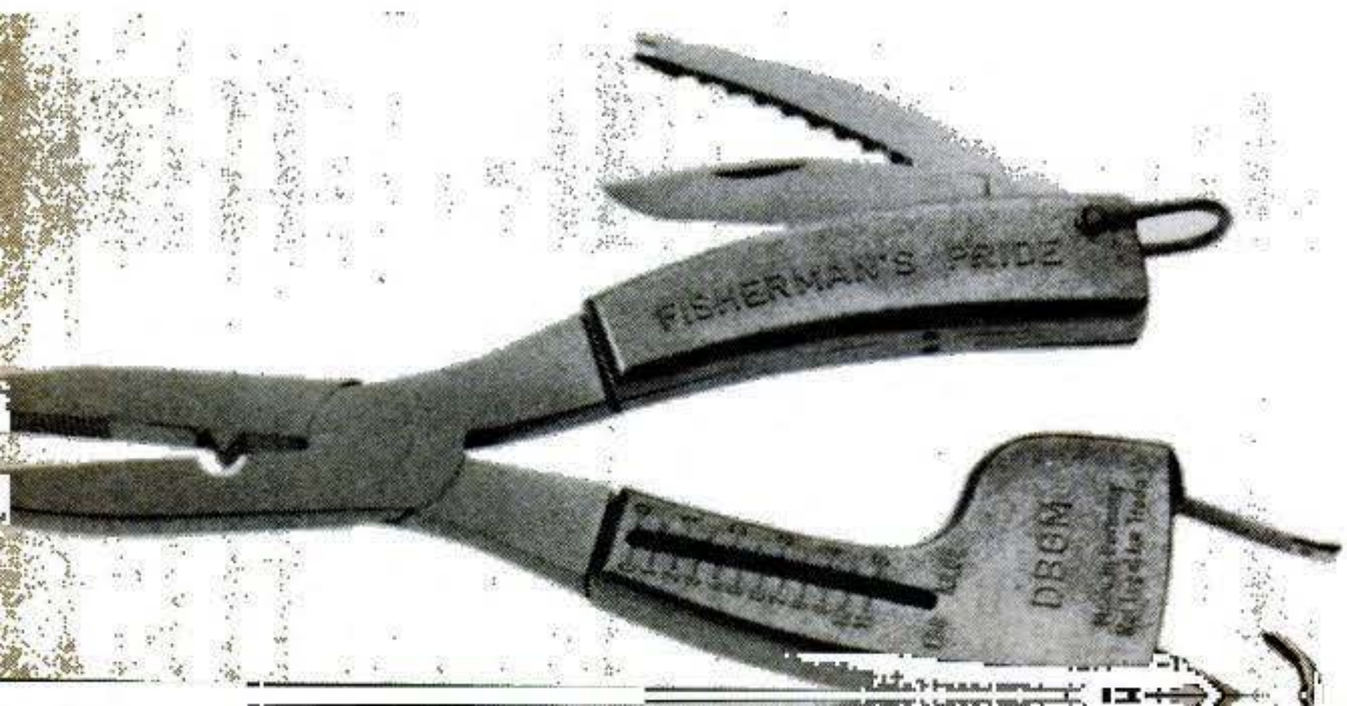


Low-cost high-performance reel

A new "98" spin-cast reel from Johnson boasts built-in trouble-free operation with no-backlash casting. Featured are adjustable Star Drag to assure fish control with no line twist and a 12-point pickup system that retrieves even slack line. It's equipped with 510 feet of 10-pound-test monofilament line. Price of the reel is $11.95. Also offered as a rod-reel combination—the new reel plus a six-foot two-piece tubular glass rod, $22.95. Available, singly or as a combination, at sporting-goods stores.

Cool it with this creel

Made of heavy burlap and vinyl, Dip 'N Cool creel uses the same cooling principle as the old desert waterbags. Just dip in the stream and evaporation keeps it, and the fish inside, cool. Cost: $2.95 at tackle shops. Columbia Sportswear, 6600 N. Baltimore St., Portland, Ore. 97203.



Tool does everything but the fishing

Here's a gadget that gives you every tool you need (including a bottle opener) plus a spring scale to weigh catches of one to 11 pounds. It's a hook degorger, scaler, knife, pliers, shot splitter for sinkers, and more. The forged-steel Fisherman's Pride sells for $9.95. Riordan Enterprises Inc., Box 198, Chappaqua, N.Y. 10514.

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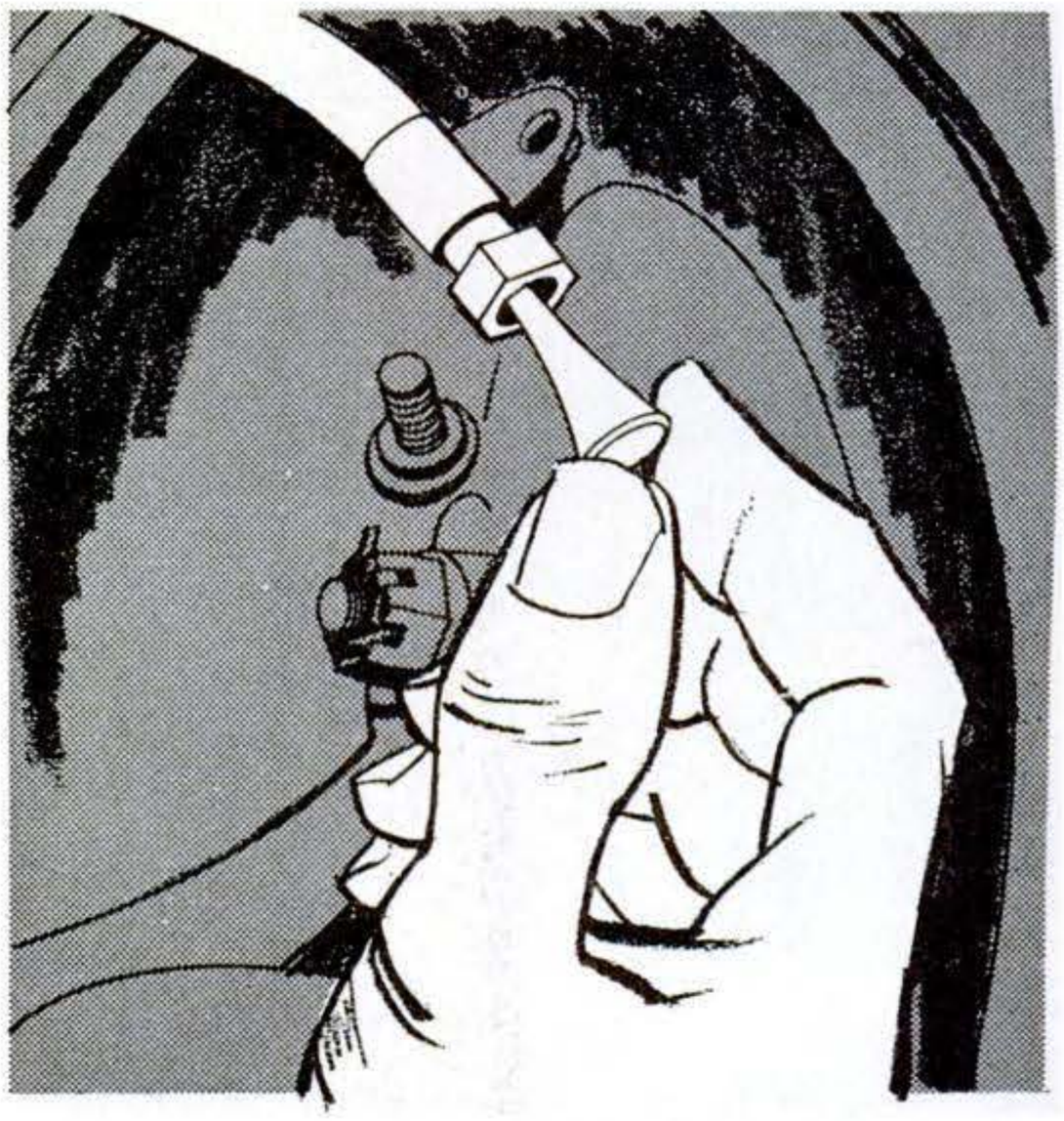
Hints from the Model Garage

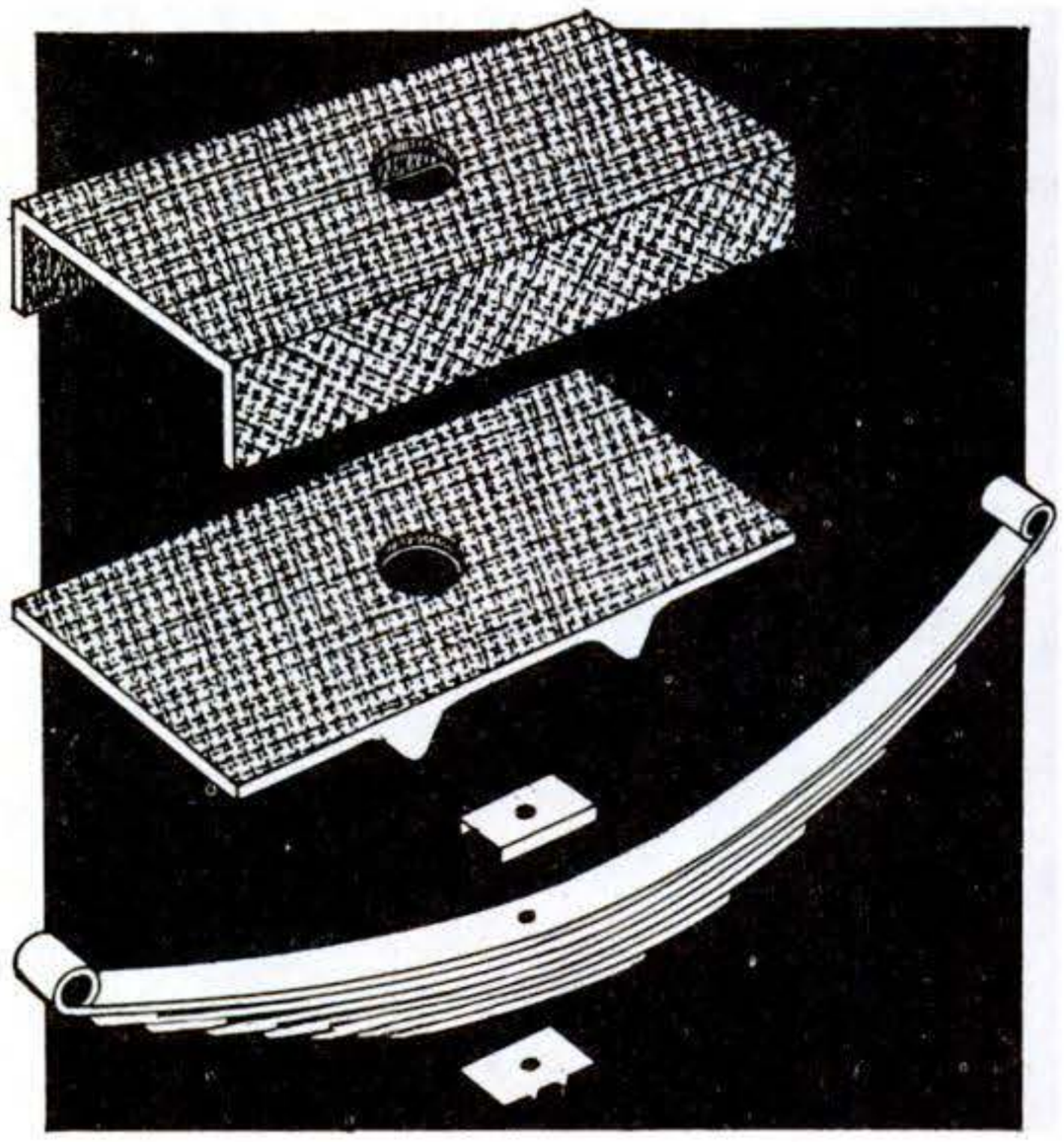
DRAWINGS BY RAY QUIGLEY

Tired of nicks and scratches on your doors and fenders? Place magnetic plastic strips along the widest line on your car. The strips are one inch wide and come in rolls three feet long. The pliable plastic tape is coated with magnetized iron oxide.



Keep a few wooden golf tees in your tool kit. Their tapered shape makes them ideal plugs for use in hydraulic brake lines to prevent loss of fluid when the wheel cylinders are removed. You may find plastic tees usable, but wood seals better than plastic.

Repair a stripped car-door lock button the easy way by using a screw-on terminal nut or cap from a spark plug as a liner. Drill the button with a 7/32″ bit (make sure you don't drill through) and press-fit the nut. Screw the lock button back on its rod.



You can cut road noise in your Dodge or Plymouth by fitting Imperial insulators in the rear-spring attachment to the axle. Part numbers are 1731796 and 1731798. The total cost is just over $1.00. The insulators are available from any Chrysler dealer.

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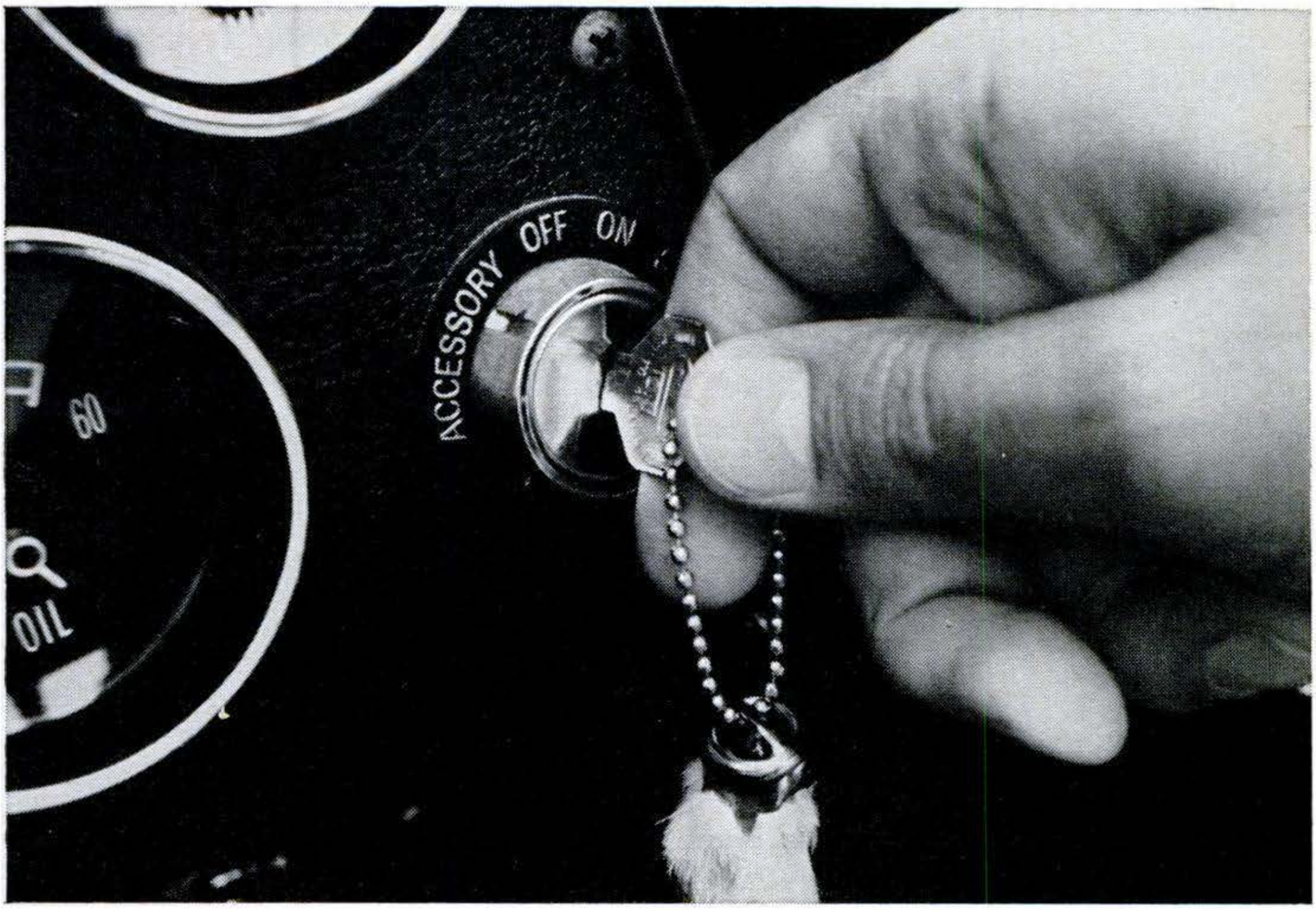
The start of the finish.



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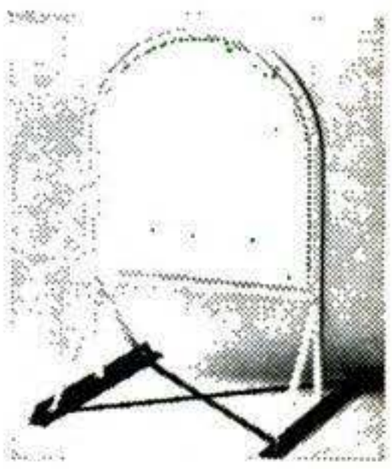

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[Continued from page 105]

saddles for cables were on rollers to permit the cables' longitudinal and tension-equalizing movement, in response to varying temperatures and loads.

Then came flexible towers—whose bases were fixed, but whose tops could sway with the cables.

Rocker towers, whose introduction was hailed by engineers as the next forward step, are free to rock back and forth with the cables. Instead of having fixed bases, they stand on curved shoes, bearing against flat ones on the piers. Nothing anchors the bottom of a tower—aside from loose-fitting dowels to keep it from shifting. Sliding or rocking connections support the roadway structure, passing through a tower, without hindering the tower's movement.

Silver Bridge was almost the first of its size in the U.S. to have rocker towers. (A wire-cable suspension bridge at Portsmouth, Ohio, preceded it by a year.)

Often used since, rocker towers are sound and advantageous. Importantly, they avoid the strain put on a pier by the bending of a flexible-type tower. This advantage applies especially to medium-size suspension bridges, whose towers lack the inherent flexibility of the biggest bridge's high ones.

However—and this proved a big "however" in Silver Bridge's case—a rocker tower presupposes that the safety of the cables, or eyebar chains, is beyond question. For those are what it depends on to brace it and hold it up.

If Silver Bridge's eyebar chains broke, or went slack from a structural failure elsewhere, down would come the towers. Even a single chain's parting or slacking would be catastrophic. ("If one chain goes, it all goes," comments an Ohio bridge engineer.)

One of these things must have happened—for both towers did fall.

The rocker towers seem to solve the mystery of how Silver Bridge could collapse in seconds, and claim so many lives.

A bridge's fall that was another story. For a contrasting example, take the spectacular collapse in 1940 of the Tacoma Narrows Bridge—then the world's third-longest suspension bridge. Designed too flexibly, it was twisted apart by wind. Almost all the 2,800-foot main span's suspended structure fell, piecemeal, into waters below. But the five people on the bridge were unhurt. Though damaged, the great cables held; though wrenched and bent, the towers stayed up. And so did the side spans that gave an escape route to safety.

If overloading felled Silver Bridge, and its remarkable design explains the record death toll—and so it appears—all that remains is to reconstruct the details.

Hunting clues. Still unknown at this writing was what gave way first, and the exact sequence of what followed. Best hope of finding out, if ever, lay at a 27-acre plot near the bridge site. There, airplane-crash style, investigators were reassembling wreckage from the shore and river bottom in search of clues.

Lengths of eyebar chains that fell on the Ohio shore were intact. Reportedly under suspicion was a broken eyebar-chain support, at the extreme Ohio end, over which the north eyebar chain made its sharpest bend between tower and anchorage. But it was a formidable problem to distinguish what broke first from what parted later. The study was expected to take a year.

Meanwhile the tragedy is spurring intensive safety checks of bridges all over the nation. West Virginia, for one, began a searching inspection of its 500 major bridges. One in particular, understandably, is getting an extra-special going-over that may take months.

St. Mary's Bridge over the Ohio, some 70 miles upstream from Silver Bridge and built about the same time, is its exact twin—and is believed its only U.S. counterpart. If St. Mary's Bridge proves free of flaws, possibly special limits may be imposed on its traffic's weight and spacing. Discovery of defects calling for the bridge's repair, strengthening, or replacement might throw more light on what happened to Silver Bridge.

What it all adds up to is that you can be reassured about the safety of bridges you'll cross. Not only is the disaster inspiring nationwide precautions, but also —with the sole exception just noted— you'll never encounter another bridge like Silver Bridge. PS

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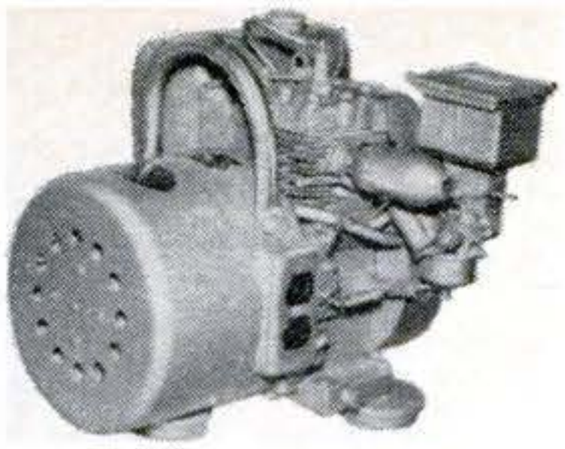

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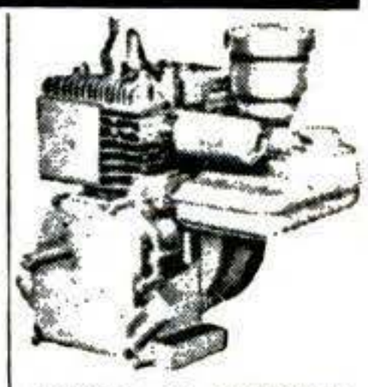

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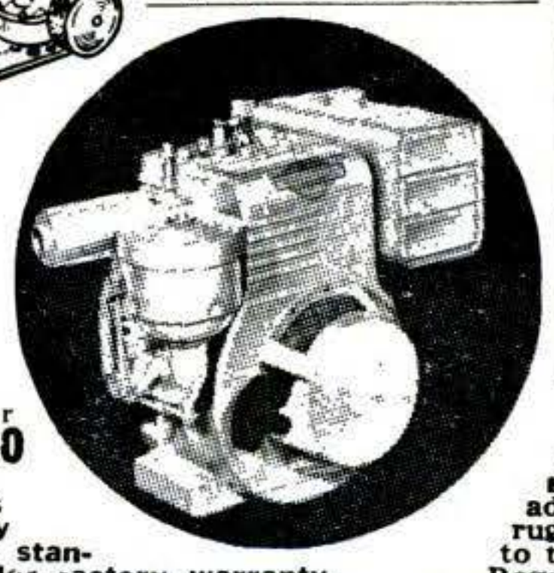

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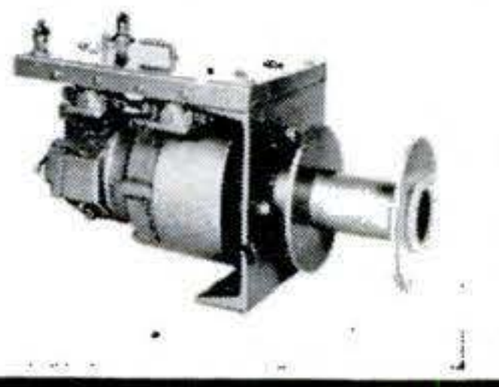

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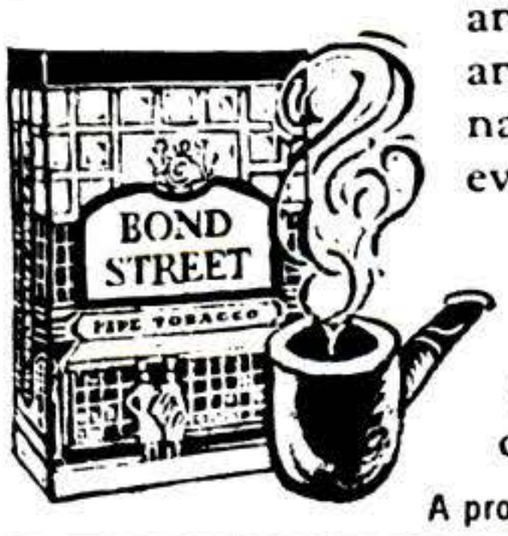

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[Continued from page 173]

too chicken, either. The right feed and speed will spiral off material like shavings on a metal-turning lathe.

Lathe work. The material really shines here, but forget your skillful gouge and skew techniques and stay with a scraping action for all tools. Prepare blanks by precutting on the bandsaw or table saw to minimize heavy stock removal. I preferred working with slightly higher speeds than I would use for untreated wood under similar conditions. You can do fast shaping with a scraping action if you place the rest so that the tool edge is slightly below center; then bring the edge up as you begin to cut.

Lathe skill with this material comes pretty fast, even though you will have to sharpen the tools frequently. Prepare stock for spindle-mounting by making crosscuts with a handsaw and drilling for center points. If available, use a live center in the tailstock.

Finishing. Work through progressively finer grits of aluminum oxide, open-coat sandpaper—No. 80 to 100 to 220 is a good sequence if you have been careful about doing all work to that point. A belt sander or pad sander can be used on surfaces while hand-held strips of sandpaper should be used on lathe work.

Follow sanding with lots of rubbing with rottenstone. This is best applied, especially on lathe work, in paste form by premixing the rottenstone with oil. After rubbing, clean and polish with a soft cloth. Optimum luster results when you generate enough heat through polishing friction to glaze the plastic at the surface. Of course this is easiest on a lathe, so you'll get your best finishes there.

For other work you can mount a cloth buffing wheel on a flexible shaft or even on a portable drill. Work at between 1,700 and 2,000 r.p.m. The manufacturer suggests dry-polishing with a pumice block. With any order, they'll supply a small one for 60 cents. If you're curious, try out both methods.

One of the big advantages of this material is that surface damage to completed projects (scratches, chemical stains, burns, etc.) can be quickly repaired simply by repeating the finishing procedure over the damaged spot. PS

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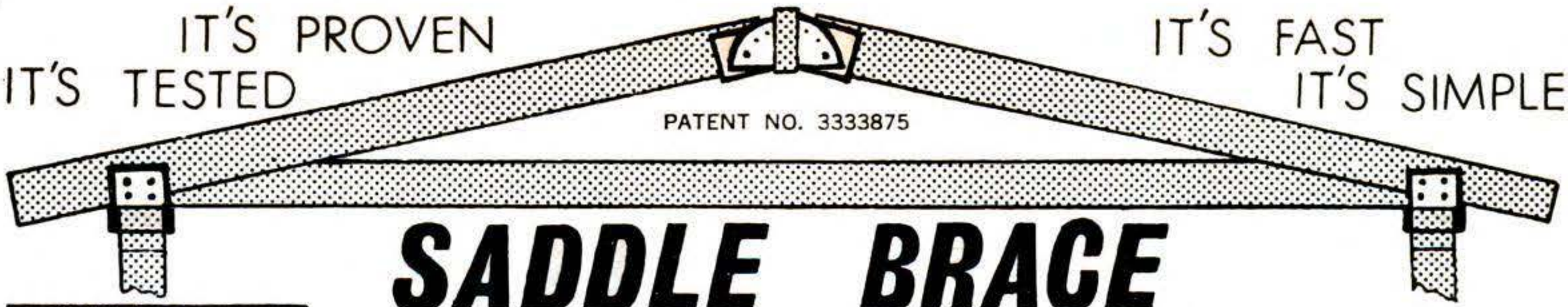

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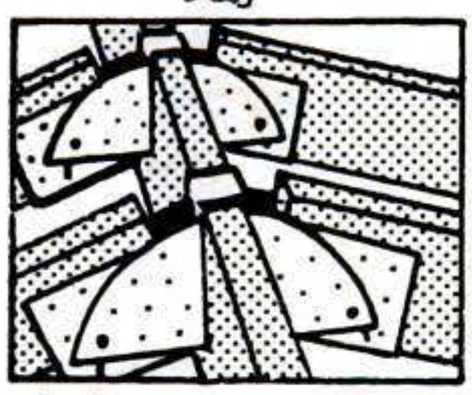

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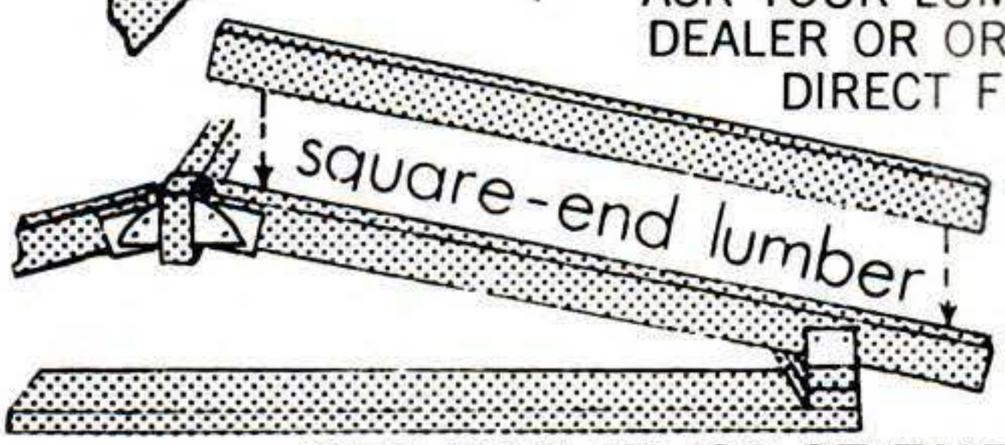

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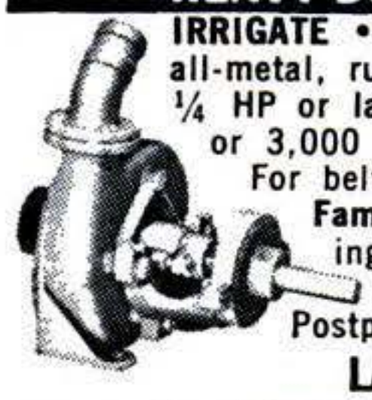

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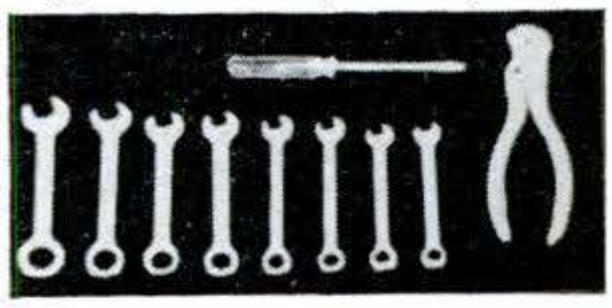

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[Continued from page 148]

price gap, if any, is not necessarily of "rule-out" size for the user who needs a tractor for long hours and rough going. Any of the 10- and 12-hp. tractors will more than cope with suburban-level jobs.

The "L" in LGT. A major LGT executive told me, "I can cut my one-acre lawn with our 32-inch lawn tractor in about three-quarters of the time it would take me with our big 48-inch garden tractor because I've got so many bushes and flowers to jog around." He was pointing up one of the merits of the L, or lawn tractor, the small tractor-like grass cutter that peaks out at about seven hp. Other good things about them:

- They go through garden-shed doors and gates handily.
- They're easy on soft lawns and grass.
- Even with recoil start most women and youngsters can manage them.
- They pull two-wheel trailers, rollers, and sweepers nicely.
- In moderate snow or soft earth they do a fair job of blading.
- Less trimming is needed afterwards.

Mower or tractor? Statistics prove that LGTs are first and foremost bought for mowing. Other implements, starting with snow blades and blowers, run far down the line in sales.

It follows that the small end of the line blends with riding mowers at the five-six-hp. level. Some of the lawn tractors are well built; others aren't. Look for:

- Wheel quality, wheel bearings and lubrication, tire size and type.

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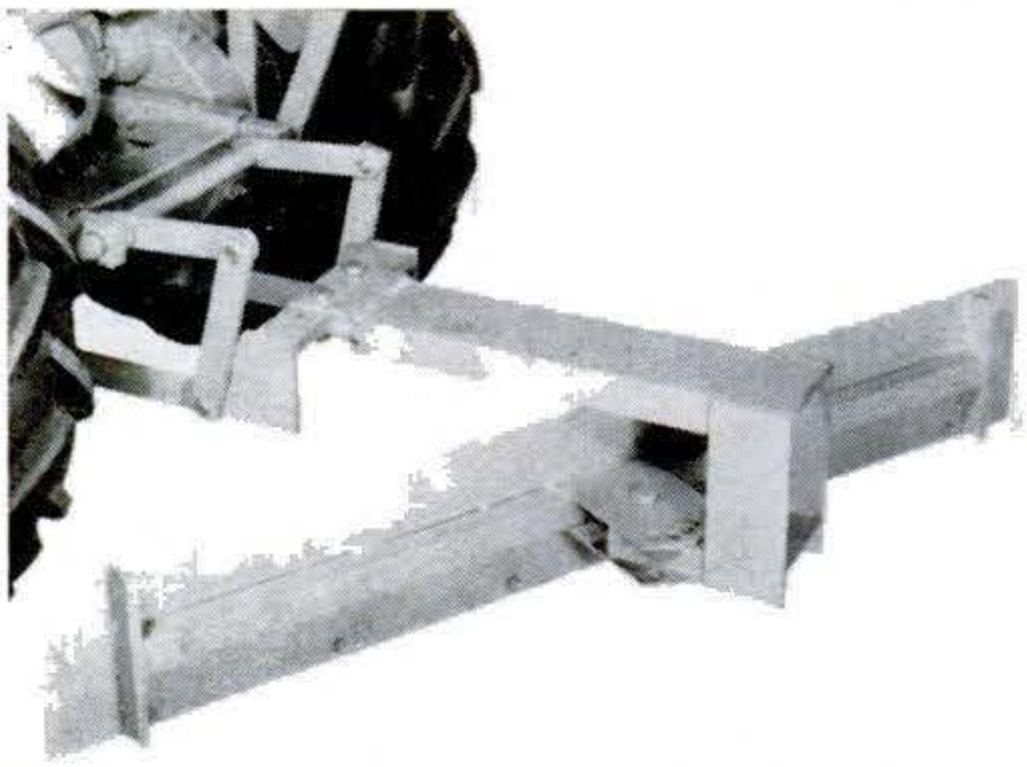

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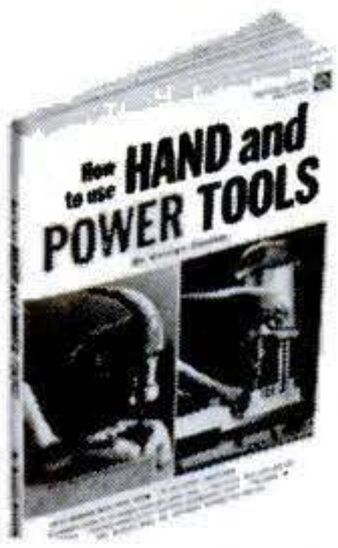

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So pleased I had to write. Had berries all summer long to frost. Big, juicy, some large as plums. D.B.W. Poughkeepsie, N.Y.

Plants were simply great, 59 out of 60 lived. R.A.W. Lurton, Ark.

Planted on Apr. 17. They are now in full bloom, May 13. R.H.R. Sarasota, Fla.

Raised so many berries we glutted the market. J.B. Wabash, Ind.

Received plants. These are the best I ever bought. W.L.N. Eagle, Idaho

Plants are growing exceptionally well. I know nothing about raising strawberries. R.B.W. Cocoa Beach, Fla.

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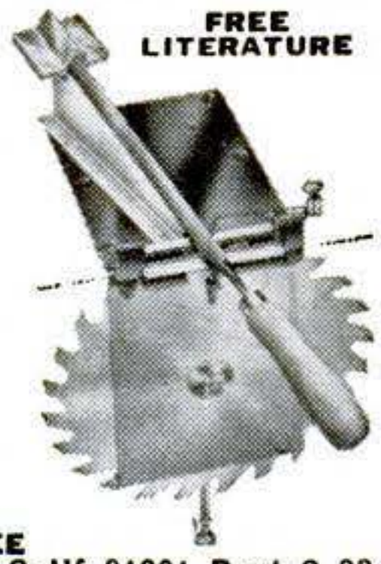

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Buyer's Guide to '68 Garden Tractors

- Controls: Check tie-rod ends, handles, linkages. Avoid small, stamped-out parts, cotter-pinned steering-rod ends.
- Safety features: Exposed belts, hot manifolds, back-tipping tendencies.
- Materials: metal gauge, weld quality, paint and rust protection, use of soft die castings instead of steel or iron.

Most, but not all, makers of garden tractors also make lawn tractors. In general, if a manufacturer has a name to protect in the larger sizes, his lawn tractor will be of good quality.

DeVere Locke two-wheel tractor is a pure power package, made to industrial standards for snow removal or grass cutting. It's heavy-duty throughout.

Engine improvements. Sharp buyers will inquire about new engine features that improve starting, ease or eliminate ignition maintenance, and reduce vibration. In many cases these features are options that a tractor manufacturer may or may not elect to buy. Worth your while asking about:

- Ceramic magneto ignition for hot spark at low cranking r.p.m. (Briggs).
- Synchro-balanced crankshaft for minimum vibration to operator (Briggs).
- Automatic compression release (ACR) for easy starting (Kohler).
- Solid-state voltage regulation, alternator charging (Kohler).
- Solid-state breakerless ignition, no point maintenance (Kohler, Tecumseh).

Incidentally, don't be worried about compression if you turn over some of the new engines by hand and miss the old-time compression bounce. Briggs and

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Tecumseh have special cam designs to relieve compression at starting speeds for easy hand or electric starting, especially in cold weather. Kohler does the same thing by an ingenious, patented centrifugal device on the cam.

Solid-state, breakerless ignition systems eliminate the major cause of hard starting and service calls. With all components sealed, not much can go wrong.

The combination starter/generator with belt drive also seems to be giving way to the flywheel alternator and the Bendix or geared-type starter.

Briggs has scored well with their synchro-balanced crankshaft, which cuts engine vibration by about 80 percent. This feature is now available on vertical-shaft engines. Kohler has a similar dynamic balancer for 10- and 14-hp. engines. Fourteen horsepower has not yet been used in the domestic-level machines, but the grapevine suggests it's coming.

Special features. Some are admittedly sales boosters aimed at style- and prestige-conscious buyers. Big chrome hubs, simulated walnut paneling, glamorous grilles, and luxury seats sell more tractors than roller-bearing king-pins.

Other features are not all froth on the pudding. They point up the trend to greater safety, more sophisticated design, and closer field evaluation of user problems. Among them:

- Hydraulic implement lift—a tremendous help in implement use.
- Wheel brakes.
- Limited-spin differential.
- Variable-speed drive on gear-driven tractors.

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several of the garden-size tractors this year and it will prove a boon at any job where a heavy cutter deck, scraper blade, or rear-mounted tiller must be raised or lowered. Powerful tractors require heavy implements to resist loading and stay on the ground where they can work.

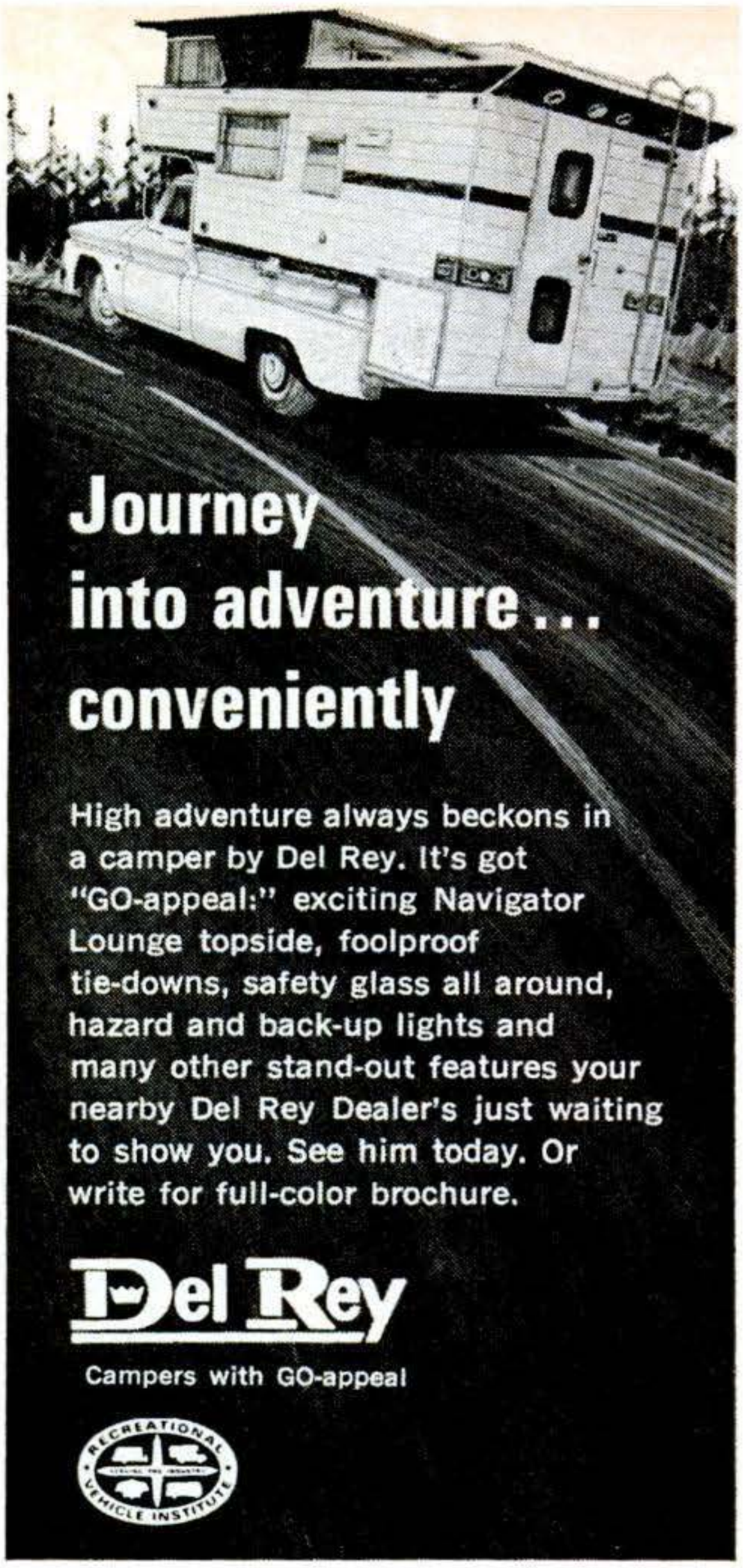
Getting these tools off the ground for height adjustment and transport can be a workout—unless hydraulic power is available. Down pressure is equally handy when packed snow or earth wants to force the implement up. A good hydraulic system will actually raise the front end of the tractor and place all the front weight on the implement. Hydraulic couplings and pump arrangement vary. Some use power from the drive system, others mount separate pumps.

The Deere 140 has dual hydraulic couplings of the quick-connect type up front and other connections aft and center. The second connection at the front permits angling the implement in addition to up and down. Neutral control position allows the implement to "float."

Wheel brakes and parking brakes. These offer added safety even though both hydro and most mechanical drives provide some braking action. When buying, check for disks, internal drum, or shaft brakes. A special feature on the Gravely 424 is individually controllable rear-wheel brakes, dandy for getting out of trouble when one wheel is spinning.

An equivalent performance to stop free-wheel spin is gained from limited-slip or automatic power-transfer differentials as in the Wheel-Horse Charger and Raider line.

In spite of the attractive features of the hydro transmission, it is worth noting that a good gear transmission, coupled with a variable-speed drive, can provide great power application and speed flexibility and do it on the move. Outstanding drives of this type are found on Allis-Chalmers, Deere 110 and 112, Gilson S series, Massey-Ferguson MF-10, Ward's Squire 10 and 12, and Simplicity's Sovereign 3012, plus others. In essence, a variable spacing on the belt-drive flanges provides a ratio change with complete smoothness and under load. This ratio change is superimposed on the basic gear ratio selected for a given job. PS



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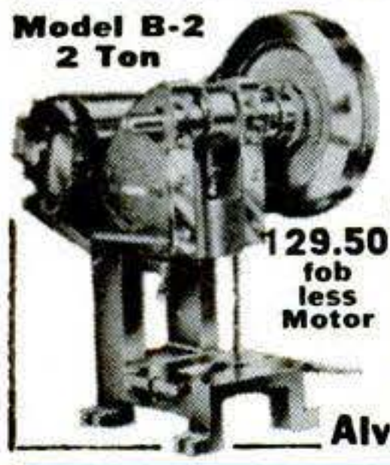

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Birdman Kite

[Continued from page 142]

ı twist of your wrists. When you want o land, kill the motor and drift back o earth like thistledown.

If this all sounds like science-fiction, remember that the notion of man exploring deep water without a diving suit was considered fantastic before scuba gear was developed. If man can swim like a fish, why can't he fly like a bird?

Rough, back-of-envelope figures suggest it would be possible to put together personal wings that—with a 10-horse engine—would weigh about 60 pounds. Lifting area would be twice that of a modern lightplane. And pressure would belly the sail-like wings into the proper shape, and control would be effected by a spanwise cable attached to the trailing edge. A pull on one side would produce bank and turn; a pull on both sides, climb. Careful design could make it safe: Flexible spars would increase the incidence of the wing to cut speed.

Building the model. Our model of this dream-scheme is easily put together. Wing spars are best made of spruce, but pine or very hard balsa will do. Joints between them are reinforced with fitted hard-balsa gussets. Use plenty of cement and allow to set up well before lifting.

The dummy motor and prop are carved from balsa scrap—you'll need a block ½" by ⅝" by 1" for the motor, and one ¼" square and 2½" long for the prop. Fit the prop with a bearing of 1/16" (o.d.) aluminum tubing so it will spin freely on a common pin shaft.

The pilot mounting board is held to the wing frame by a metal bracket with spurs for piercing and clinching. The pilot figure is carved from three ¾"-thick medium-soft balsa blocks. The added feet and facepiece are ¼" scraps. Two rubber bands, figure-eighted around the body, harness it to the board.

Cover the wing frame with lightweight model tissue, attached with model cement or white glue. Don't water-shrink or dope this covering. Triangular reinforcements of tissue at the far ends of the spars will increase durability.

To fly the model as a glider, make up a simple paper-clip hook and attach to the pilot's chest. The line drops off when tow pressure is relaxed. PS

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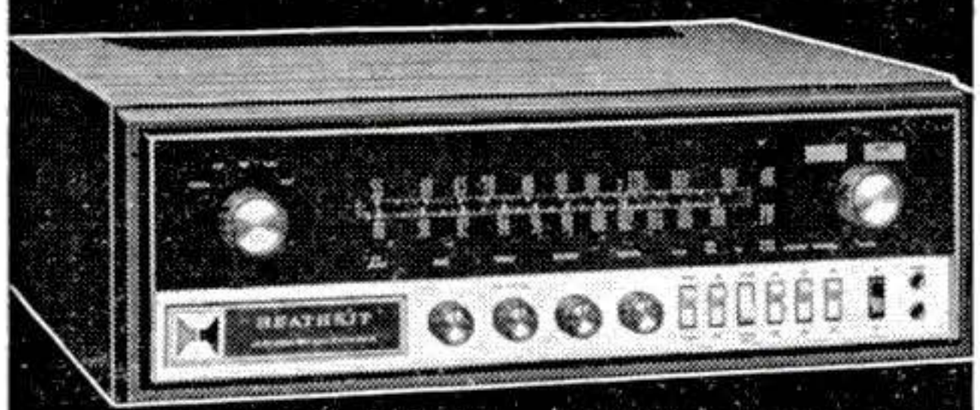

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How I Became a Walking Weapon

[*Continued from page 79*]

doing. We bowed to each other and he said, "Go for my face." I did.

"No. You pulled way too early. Come on, now—punch!"

Annoyed now, I tried again. But my blocked arm ricocheted over his shoulder with a forearm-splintering smack. I aimed for his chest; my hand was diverted past his side. I tried to kick him in the chin; he blocked, and I did a split.

Three times a year, students try for a higher rating. You have to know the basic forms perfectly, know the elemental *katas*, do well in sparring, and in a bow to show biz, break a board.

Actually, it was way too early for me to try, but when the next promotion program was scheduled, I joined it. All around me I could feel the tension and strain build, as we sat in a bunch on the floor while Master Pai called us up.

When my turn came, in basic steps and *kata* I was fine, a sheer delight to watch. Then just before the board-breaking someone told me of the time a few months ago when an ex-boxer, the first one up, hit the board wrong and broke his wrist.

I stepped to the foot-square, ¾-inch thick, knotfree board held by a brown belt with another guy bracing him, and formed my *shuto* knife-hand, measured the distance, and swung with a lusty "Haaa!" To my astonishment, the board splintered.

Then came the sparring. Disaster. A stranger from another class was my partner, someone with a curious glint in his eye and an extraordinarily fast foot. It's a good thing he wasn't serious about maiming me, because every time he struck at one place, I was blocking another. Master Pai looked disgusted.

Disqualified. Then I attacked—and kicked my partner in the ribs. "Gannon, you've got no control," said Pai sadly, disqualifying me as my partner writhed.

So I flunked. No green belt. But I did learn something: If sometime I get in a position where I have to fight, I'll be able to—but not against another *karateka*. Meanwhile, I'm going to keep looking for my missing *ki* (karate-power psychic center). When I find it I guess I'll have to register my hands with the police. PS

Army's 250-m.p.h. Chopper

[*Continued from page 83*]

hange pitch at the back. Steel rods run rom the swash plate up to the control yro. A pitch link from each of the four ontrol-gyro arms is connected to a feathring mechanism of four blades in the otor which—remember—is the main gyoscope. The rotor also precesses at 90 egrees.

Now there is one vital little item remaining. The control stick must impart ressure to the swash plate, but not novement. Therefore, interposed beween the pilot's stick and the plate is a pring. It imposes pressure on the plate ithout mechanical movement. This preesses the control gyro, which precesses he rotor.

A cinch to fly. Don Segner, chief test ilot on the project, says the Cheyenne s so easy to fly that he can check out a xed-wing pilot in it in 10 minutes.

Segner (seen looping an experimental redecessor of the Cheyenne on page 79, PS, June '67) was not the first to loop a hopper. Flapping-blade choppers have een looped by building up excess speed nd whipping them over the top before he fuselage had a chance to "fall hrough" the flapping rotor. But he is he first to handle a chopper in loops and olls as though it were a fixed-wing lane.

The fact is, the Cheyenne becomes almost a fixed-wing plane at high speeds. When it's doing 250 m.p.h., the rotor becomes mostly "unloaded," delivering less han 10 percent of the lift, and stub fixed vings sustain 90 percent of the aircraft's veight. A conventional propeller on the ail, at a right angle to the torque screw, ives most of the forward propulsion at hat speed. One General Electric 3,400-p. gas turbine powers all this.

The Army, always at loggerheads with he Air Force over who will own what ombat aircraft, is delighted with the Cheyenne. As a gyro-stabilized gun platorm with computerized fire control and aser-beam range-finding, it is designed to scort troop-transport choppers into battle. But it also is capable of search-andlestroy missions, flying low and slow, or igh and fast, with a versatility beyond hat of fixed-wing jets. PS

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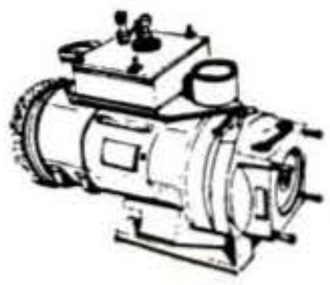

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Free Lance Writing for Fun & Profit
Introductory Technical Writing
Modern Letter Writing
Practical English
Short Story Writing

HIGH SCHOOL
High School Business
High School (Canadian)
High School College Prep. (Arts)
High School College Prep. (Engineering & Science)
High School General
High School Mathematics
High School Secretarial
High School Vocational

LANGUAGES
(Edited by Berlitz)
French German
Italian Spanish

LEADERSHIP
Basic Supervision
Industrial Foremanship
Industrial Supervision
Modern Woman as a Supervisor
Personality Development
Personnel-Labor Relations
Supervision

MATHEMATICS
Advanced Mathematics
Mathematics and Mechanics for Engineering
Mathematics and Physics for Technicians
Mathematics and Physics for Engineering
Modern Elementary Stat.

MECHANICAL
Aircraft & Power Plant Mechanics
Hydraulic & Pneu. Power
Industrial Engineering
Industrial Management for Engineers
Industrial Eng'r'g Tech.
Industrial Instrumentation
Machine Design
Mechanical Engineering
Quality Control
Safety Eng'r'g Tech'l'gy
Tool Design Value Analysis
Vibration Analysis and Control

PETROLEUM
Natural Gas Production & Transmission
Oil Field Technology
Petroleum Production
Petroleum Prod. Eng'r'g
Petroleum Refinery Oper.
Pipeline Engineering Tech.

PLASTICS
Design of Plastic Products
Plastics Technician

PLUMBING, HEATING, AIR CONDITIONING
Air Conditioning
Air Conditioning Maint.
Domestic Heating with Oil & Gas
Domestic Refrig. Heat'g
Heating & Air Conditioning with Drawing
Industrial Air Conditioning
Industrial Heating
Pipe Fitting Plumbing
Plumbing & Heating
Plumbing & Heating Est.
Practical Plumbing
Refrigeration
Refrigeration & Air Cond.

PULP AND PAPER
Paper Machine Operator
Paper Making, Pulp Making
Pulp & Paper Engineering
Pulp & Paper Making

SALESMANSHIP
Creative Salesmanship
Real Estate Salesmanship
Sales Management
Salesmanship

SECRETARIAL
Clerk-Typist Commercial
Engineering Secretary
Legal Secretary
Medical Secretary
Professional Secretary
Shorthand Stenographic
Typewriting

SHOP PRACTICE
Drill Operator
Foundry Practice
Industrial Metallurgy
Lathe Operator
Machine Shop Inspection
Machine Shop Practice
Machine Shop Practice & Toolmaking
Metallurgical Eng'r'g Technology
Milling Machine Operator
Multicraft Maintenance Mechanic
Practical Millwrighting
Reading Shop Prints
Rigging
Tool Eng'r'g Tech'l'gy
Tool Grinder Toolmaking
Turret Lathe Operator
Welding Engineering Tech.
Welding Processes

STEAM AND DIESEL POWER
Boiler Inspector
Industrial Building Eng'r
Power Plant Engineering
Stationary Diesel Engines
Stationary Fireman
Stationary Steam Eng'r'g

TEXTILES
Carding
Carding and Spinning
Dyeing & Finishing
Loom Fixing Spinning
Textile Designing
Textile Mill Supervisor
Textile Technology
Warping and Weaving

TRAFFIC
Motor Traffic Management
Railway Rate Clerk
Traffic Management

TV-RADIO-ELECTRONICS
Color Television Principles & Servicing
Communications Techn'l'gy
Electronic Fundamentals
Electronic Fundamentals (Programmed)
Electronic Fundamentals with Electronic Equipment Training
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